Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
1. Young WB. The clinical diagnosis of myelopathy. *Semin Ultrasound CT MR.* 1994;15(3):250-254.	Review/Other-Dx	N/A	A clinical review of myelopathy.	General examination may point to systemic disease associated with myelopathy. Neurological examination excludes cerebral disease. Motor and sensory examination may define the level of the lesion. Physical examination localizes not only the level of the spinal cord lesion but the anatomic distribution of the lesion within a given level. When tumor or paraspinal infections are diagnostic possibilities, emergent imaging of the spine is required.	4
2. Kent DL, Haynor DR, Longstreth WT, Jr., Larson EB. The clinical efficacy of magnetic resonance imaging in neuroimaging. *Ann Intern Med.* 1994;120(10):856-871.	Review/Other-Dx	156 studies	To assess the clinical efficacy of MRI for neuroimaging and to provide guidelines for clinical practice.	MRI shows greater contrast and detail than CT but also shows more clinically silent abnormalities or incidental findings. A few studies found a modest impact on therapeutic choices but no impact on quality of life or disability. Costs for MRI are high. CT is sufficient for initial diagnosis of most mass lesions or intracranial hemorrhages requiring immediate intervention. MRI is more accurate in the temporal lobes, posterior fossa, brainstem, and spinal cord. For lumbar radiculopathy, MRI and plain spinal CT are as accurate as post-myelographic CT and are less invasive. The role of MRA for carotid artery stenosis is being studied.	4
3. Rapoport RJ, Flanders AE, Tartaglino LM. Intradural extramedullary causes of myelopathy. *Semin Ultrasound CT MR.* 1994;15(3):189-225.	Review/Other-Dx	N/A	To review the utility of contrast-enhanced MRI in the detection of intradural extramedullary causes of myelopathy.	Recognition of morphological patterns, signal intensities, and enhancement patterns frequently permits a specific diagnosis or a limited differential diagnosis.	4
4. Rothman MI, Zoarski GH, Akhtar N. Extradural causes of myelopathy. *Semin Ultrasound CT MR.* 1994;15(3):226-249.	Review/Other-Dx	N/A	To review the plain film, CT, and MRI demonstration of extradural causes of myelopathy.	MRI study of choice.	4
5. Tartaglino LM, Flanders AE, Rapoport RJ. Intramedullary causes of myelopathy. *Semin Ultrasound CT MR.* 1994;15(3):158-188.	Review/Other-Dx	N/A	To review imaging of intramedullary processes of the spinal cord.	MRI is procedure of choice. Patterns of signal abnormality, enhancement, and morphology are described that can be used to separate neoplasms, inflammation, infarction, vascular anomalies, degenerative processes, and congenital anomalies as they affect the spinal cord. Recognition of these patterns is essential for prompt and appropriate medical and surgical treatment.	4

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
6. Oh JK, Lee DY, Kim TY, et al. Thoracolumbar extradural arachnoid cysts: a study of 14 consecutive cases. *Acta Neurochir (Wien).* 2012;154(2):341-348; discussion 348.	Review/Other-Dx	14 patients	A retrospective review of medical records and imaging studies was performed to investigate characteristic clinical and radiological features of extradural arachnoid cysts in the thoracolumbar region.	Progressive motor weakness was the predominant symptom in all patients. 9 patients had radicular leg pain and back pain in the thoracolumbar area. On MRI, the cyst compressed the dural sac and spinal cord posteriorly typically with bilateral foraminal extensions. On radiological study, a communication point with the subarachnoid was hardly observed. The surgical treatment of extradural arachnoid cysts included complete resection of the walls and closing the communicating point with the subarachnoid space. All patients showed excellent outcomes according to Odom's criteria without recurrence. One CSF leakage and 1 postoperative hematoma were noted.	4
7. Budzik JF, Balbi V, Le Thuc V, Duhamel A, Assaker R, Cotten A. Diffusion tensor imaging and fibre tracking in cervical spondylotic myelopathy. *Eur Radiol.* 2011;21(2):426-433.	Observational-Dx	20 patients and 15 volunteers	To 1) obtain microstructural parameters (FA, mean diffusivity) of the cervical spinal cord in patients suffering from CSM using tractography, 2) to compare DTI parameters with the clinical assessment of these patients 3) and with information issued from conventional sequences.	The FA values of patients were significantly lower at the compressed level than the FA of volunteers at the C4-C7 level. A significant positive correlation between FA at the compressed level and clinical assessment was demonstrated. ISI on T2-weighted images did not correlate either with FA or mean diffusivity values, or with any of the clinical scores.	2
8. Hori M, Fukunaga I, Masutani Y, et al. New diffusion metrics for spondylotic myelopathy at an early clinical stage. *Eur Radiol.* 2012;22(8):1797-1802.	Observational-Dx	50 patients	To investigate the use of root mean square displacement and mean diffusional kurtosis metrics of q-space imaging data to estimate spinal cord compression in patients with early cervical spondylosis.	FA and mean diffusional kurtosis values were significantly lower and root mean square displacement was significantly higher (P=0.0060, 0.0020 and 0.0062, respectively; Mann-Whitney U test with the Bonferroni correction) in compressed spinal cords than in uncompressed cords. ADC was also higher in compressed cords, but this difference was not statistically significant.	3

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
9. Jones JG, Cen SY, Lebel RM, Hsieh PC, Law M. Diffusion tensor imaging correlates with the clinical assessment of disease severity in cervical spondylotic myelopathy and predicts outcome following surgery. *AJNR Am J Neuroradiol.* 2013;34(2):471-478.	Observational-Dx	30 patients	To systematically explore the relationship between clinical disease severity and DTI in CSM, and to investigate the potential use of DTI in surgical decision-making models.	At diagnosis, FA demonstrated a strong correlation with baseline Japanese Orthopedic Association (JOA) (r = 0.62, *P*<.01) and Nurick (r = -0.46, *P*=.01) scores. After surgery, recovery of function demonstrated by improvement in NDI score was associated with higher FA values on preoperative DTI (r = -0.61, *P*=.04). Severely affected patients with CSM with disproportionately high FA tended to achieve greater JOA scores after surgery compared with subjects with lower FA (*P*=.08). T2 signal intensity was associated with functional status at baseline but did not predict postoperative outcome; degree of stenosis lacked any significant correlation with clinical parameters.	3
10. Kara B, Celik A, Karadereler S, et al. The role of DTI in early detection of cervical spondylotic myelopathy: a preliminary study with 3-T MRI. *Neuroradiology.* 2011;53(8):609-616.	Observational-Dx	16 patients	To determine whether DTI may provide further information about early detection of CSM. The authors evaluated the FA and ADC values of spinal cord in patients with clinical manifestations of CSM, whose conventional MRI examinations showed no abnormal signal in T2-weighted sequences.	All patients showed changes in DTI parametrics at stenotic segments. While FA values of the spinal cord at the stenotic level showed a statistically significant reduction, there was a statistically significant increase in the measured ADC values (*P*<0.001). There was no statistical correlation between the duration of symptoms and DTI parametrics.	3
11. Kerkovsky M, Bednarik J, Dusek L, et al. Magnetic resonance diffusion tensor imaging in patients with cervical spondylotic spinal cord compression: correlations between clinical and electrophysiological findings. *Spine (Phila Pa 1976).* 2012;37(1):48-56.	Observational-Dx	52 patients	To analyze the potential of DTI of the cervical spinal cord in the detection of changes associated with spondylotic myelopathy, with particular reference to clinical and electrophysiological findings.	Significant differences in both the DTI parameters measured at the maximal compression level, between patients with compression and control group, were found, while no difference was observed at the noncompression level. Moreover, FA values were lower and ADC values were higher at the maximal compression level in the symptomatic patients than in the asymptomatic patients. The DTI showed higher potential to discriminate between clinical subgroups in comparison with standard MRI parameters and electrophysiological findings.	2

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
12. Lee JW, Kim JH, Park JB, et al. Diffusion tensor imaging and fiber tractography in cervical compressive myelopathy: preliminary results. *Skeletal Radiol.* 2011;40(12):1543-1551.	Review/Other-Dx	20 patients and 20 volunteers	To assess DTI parameters in cervical compressive myelopathy patients compared to normal volunteers, to relate them with myelopathy severity, and to relate tractography patterns with postoperative neurologic improvement.	There were significant differences between patients and normal volunteers in terms of FA (0.498 +/- 0.114 vs 0.604 +/- 0.057; *P*=0.001) and ADC (1.442 +/- 0.389 vs 1.169 +/- 0.098; *P*=0.001). DTI parameters and tractography patterns were not related to myelopathy severity. In 10 patients in the neurologically worse group, postoperative neurologic improvement was seen in 4 of 5 patients with intact fiber tracts, but only 1 of 5 patients with interrupted fiber tracts exhibited neurologic improvement.	4
13. Song T, Chen WJ, Yang B, et al. Diffusion tensor imaging in the cervical spinal cord. *Eur Spine J.* 2011;20(3):422-428.	Observational-Dx	53 patients and 20 healthy volunteers	To elucidate the usage of DTI in analyzing the early findings of the compressive cervical spinal cord and in depicting the diffusion characteristics of cervical cord in healthy volunteers of Chinese.	Intramedullary ADC and FA values were measured in 4 segments (C2/3, C3/4, C4/5, C5/6) for volunteers, in lesions (or the compressed cord) and normal cord for patients. DTI original images were processed to produce color DTI maps. In the volunteers' group, cervical cord exhibited blue on the color DTI map. FA values between 4 segments had a significant difference (*P*<0.01), with the highest FA value (0.85 +/- 0.03) at C2/3 level. However, ADC value between them had no significant difference (*P*>0.05). For patients, only 24 cases showed hyperintense on T2-weighted image, while 39 cases shown patchy green signal on color DTI maps. ADC and FA values between lesions or the compressed cord and normal spinal cord of patients had a significant difference (both *P*<0.01). FA value at C2/3 cord is the highest of other segments and it gradually decreases towards the caudal direction. Using single-shot spin echo echo-planar imaging sequence and 6 noncollinear diffusion directions with b value of 400 s mm(-2), DTI can clearly show the intramedullary microstructure and more lesions than conventional MRI.	2

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
14. Theaudin M, Saliou G, Ducot B, et al. Short-term evolution of spinal cord damage in multiple sclerosis: a diffusion tensor MRI study. *Neuroradiology.* 2012;54(10):1171-1178.	Observational-Dx	16 patients	To apply DTI techniques to MS patients with a recently diagnosed spinal cord lesion, in order to demonstrate a correlation between variations of DTI parameters and clinical outcome, and to try to identify DTI parameters predictive of outcome.	16 patients were recruited. At 3 months, 12 patients were clinically improved. All but 1 patient had lower FA and ADC values than normal subjects in either inflammatory lesions or normal-appearing spinal cord. Patients who improved at 3 months presented a significant reduction in the radial diffusivity (P=0.05) in lesions during the follow-up period. They also had a significant reduction in the mean ADC (P=0.002), axial diffusivity (P=0.02), radial diffusivity (P=0.02) and a significant increase in FA values (P=0.02) in normal-appearing spinal cord. Patients in whom the American Spinal Injury Association sensory score improved at 3 months showed a significantly higher FA (P=0.009) and lower radial diffusivity (P=0.04) in inflammatory lesion at baseline compared to patients with no improvement.	3
15. Zecca C, Cereda C, Wetzel S, et al. Diffusion-weighted imaging in acute demyelinating myelopathy. *Neuroradiology.* 2012;54(6):573-578.	Review/Other-Dx	6 patients	To describe DWI characteristics of acute, spinal demyelinating lesions.	All spinal lesions showed a restricted diffusion pattern (DWI+/ADC-) with a 24% median ADC signal decrease. A good correlation between clinical presentation and lesion site was observed.	4
16. Ducreux D, Fillard P, Facon D, et al. Diffusion tensor magnetic resonance imaging and fiber tracking in spinal cord lesions: current and future indications. *Neuroimaging Clin N Am.* 2007;17(1):137-147.	Review/Other-Dx	N/A	To discuss diffusion tensor MRI and fiber tracking in spinal cord lesions: current and future indications.	Fiber tracking offers the possibility of visualizing the integrity of white matter tracts surrounding some lesions, and this information may help in formulating a differential diagnosis and in planning biopsies or resection. FA measurements may also play a role in predicting the outcome of patients who have spinal cord lesions. In this article, we address several conditions in which DWI and fiber tracking is known to be useful and speculate on others in which we believe these techniques will be useful in the near future.	4
17. Hellmann MA, Djaldetti R, Luckman J, Dabby R. Thoracic sensory level as a false localizing sign in cervical spinal cord and brain lesions. *Clin Neurol Neurosurg.* 2013;115(1):54-56.	Review/Other-Dx	12 patients	To investigate the characteristics of patients presenting with a false localizing thoracic sensory level.	In all cases, the pathological lesion was visualized on MRI of the cervical spine or brain. 8 patients had a compressive lesion of the spinal cord and 4 had demyelinating lesions. The difference between the false localizing sensory level and the level of the cervical lesion ranged from 6 to 11 segments.	4

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
18. Como JJ, Diaz JJ, Dunham CM, et al. Practice management guidelines for identification of cervical spine injuries following trauma: update from the eastern association for the surgery of trauma practice management guidelines committee. *J Trauma.* 2009;67(3):651-659.	Review/Other-Dx	52 articles used for guidelines	Updated guidelines for the identification of cervical spine injury by the Eastern Association for the Surgery of Trauma practice management guidelines committee.	There have been significant changes in practice since the previous cervical spine injury guidelines. Most significantly, CT has supplanted plain radiography as the primary screening modality in those who require imaging. Clinical clearance remains the standard in awake, alert patients with trauma without neurologic deficit or distracting injury who have no neck pain or tenderness with full range of motion. Cervical collars should be removed as soon as feasible. Controversy persists regarding CS clearance in the obtunded patient without gross neurologic deficit.	4
19. American College of Radiology. ACR Appropriateness Criteria®: Suspected Spine Trauma. Available at: https://acsearch.acr.org/docs/69359/Narrative/. Accessed September 30, 2015.	Review/Other-Dx	N/A	Evidence-based guidelines to assist referring physicians and other providers in making the most appropriate imaging or treatment decision for a specific clinical condition.	N/A	4
20. Benzel EC, Hart BL, Ball PA, Baldwin NG, Orrison WW, Espinosa MC. Magnetic resonance imaging for the evaluation of patients with occult cervical spine injury. *J Neurosurg.* 1996;85(5):824-829.	Review/Other-Dx	174 patients	To determine the efficacy of MRI for evaluation and clearance of the cervical spine in trauma victims with no threat to spinal integrity in the early post-trauma period.	A negative MRI should be considered as confirmation of a negative or “cleared” subaxial cervical spine and MRI is useful for post trauma assessment of very select group of patients.	4
21. Davis SJ, Khangure MS. A review of magnetic resonance imaging in spinal trauma. *Australas Radiol.* 1994;38(4):241-253.	Review/Other-Dx	167 patients	Review of large experience with MRI in acute and chronic traumatic myelopathy.	All patients with a neurologic deficit had abnormal spinal cords at MRI. Intramedullary hemorrhage was predictive of a complete lesion. The degree of associated bone and soft-tissue injury had no bearing on the extent of SCI or neurologic deficit. Patients with residual cord compression following reduction demonstrated greater neurologic compromise than those without compression. MR is recommended in incomplete cord syndromes and in cord injuries with no apparent fracture, particularly if clinically deteriorating.	4

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
22. Flanders AE, Schaefer DM, Doan HT, Mishkin MM, Gonzalez CF, Northrup BE. Acute cervical spine trauma: correlation of MR imaging findings with degree of neurologic deficit. *Radiology.* 1990;177(1):25-33.	Observational-Dx	78 patients	Retrospective analysis of MRI studies to determine which observations related directly to the neurologic injury.	MRI was the definitive modality in the assessment of soft-tissue injury, especially in the evaluation of the spinal cord and intervertebral disks. All patients with a neurologic deficit had abnormal spinal cords at MRI. Intramedullary hemorrhage was predictive of a complete lesion. The degree of associated bone and soft-tissue injury had no bearing on the extent of SCI or neurologic deficit. Patients with residual cord compression following reduction demonstrated greater neurologic compromise than those without compression.	3
23. Flanders AE, Spettell CM, Friedman DP, Marino RJ, Herbison GJ. The relationship between the functional abilities of patients with cervical spinal cord injury and the severity of damage revealed by MR imaging. *AJNR Am J Neuroradiol.* 1999;20(5):926-934.	Observational-Dx	49 patients	To determine whether the presence of spinal cord hemorrhage and the size and location of spinal cord edema on MRI is predictive of functional recovery in survivors of cervical SCI.	Imaging characteristics of cervical SCI (hemorrhage and edema) are related to levels of physical recovery as determined by the functional independence measure. Imaging factors that correlate with poor functional recovery are hemorrhage, long segments of edema, and high cervical locations.	2
24. Flanders AE, Spettell CM, Tartaglino LM, Friedman DP, Herbison GJ. Forecasting motor recovery after cervical spinal cord injury: value of MR imaging. *Radiology.* 1996;201(3):649-655.	Observational-Dx	104 patients	To determine whether MRI quantification of cervical spinal cord damage improves the prediction of motor recovery after SCI.	Stepwise multiple regression analyses indicated that MRI information on hemorrhage and the length of edema increases the ability to predict clinical outcome by 16%–33% over that with initial clinical scores alone. Upper extremity motor function improved significantly in all patients ($P<.001$); patients without hemorrhage showed the largest improvements. The motor recovery rates for patients without hemorrhage were 0.74 (upper extremities; range, 0–1) and 0.55 (lower extremities; range, 0–1); those for patients with hemorrhage were 0.31 (range, 0–1) and 0.091 (range, 0–1). An initial MRI evaluation of the spinal cord after SCI provides supplemental prognostic information on the recovery of motor function in the upper and lower extremities.	4

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
25. Ghanta MK, Smith LM, Polin RS, Marr AB, Spires WV. An analysis of Eastern Association for the Surgery of Trauma practice guidelines for cervical spine evaluation in a series of patients with multiple imaging techniques. *Am Surg.* 2002;68(6):563-567; discussion 567-568.	Review/Other-Dx	124 consecutive patients, 94 males, 30 females	Retrospective study to compare the Eastern Association for the Surgery of Trauma (EAST) guidelines for 1) patients with persistent neck pain, 2) those with neurologic deficits, and 3) those who were obtunded in our study group to determine whether EAST recommendations would risk a significant missed injury rate.	The injuries identified by MRI were 4 disc herniations, 2 ligamentous injuries, 2 soft-tissue traumas, 1 meningeal tear, and 1 cord transection. 30% of patients with persistent neck pain had potentially unstable injuries not detected by 3-view radiographs or CT survey. 54% of patients with neurologic deficits had abnormal MRI. 22% of obtunded patients with normal 3-view radiographs and CT survey had an abnormal MRI. These patients have a significantly lower Glasgow Coma Score and a higher Injury Severity Score. 6% of these injuries were potentially unstable. Data support EAST guidelines for patients with persistent neck pain and neurologic deficits. The guidelines for obtunded patients appear safe in detecting bony injury but may not be sensitive enough for unstable ligamentous injury and significant disc herniations.	4
26. O'Beirne J, Cassidy N, Raza K, Walsh M, Stack J, Murray P. Role of magnetic resonance imaging in the assessment of spinal injuries. *Injury.* 1993;24(3):149-154.	Review/Other-Dx	44 patients	To evaluate the role of MRI in SCI.	MRI provided valuable information about the nature of the injuries and, in particular, about the state of the spinal cord. Appearances of the cord ranged from normal, to oedema, to more severe damage such as cord hemorrhage or transection or, in later cases, myelomalacia. The appearance of the cord on MRI correlated strongly with both the severity of the neurological deficit and also may help to identify which patients are likely to benefit from early decompression.	4
27. American College of Radiology. ACR Appropriateness Criteria®: Low Back Pain. Available at: https://acsearch.acr.org/docs/69483/Narrative/. Accessed September 30, 2015.	Review/Other-Dx	N/A	Evidence-based guidelines to assist referring physicians and other providers in making the most appropriate imaging or treatment decision for a specific clinical condition.	N/A	4

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
28. An HS, Andreshak TG, Nguyen C, Williams A, Daniels D. Can we distinguish between benign versus malignant compression fractures of the spine by magnetic resonance imaging? *Spine (Phila Pa 1976).* 1995;20(16):1776-1782.	Observational-Dx	22 patients	To determine the sensitivity and specificity of MRI in differentiating benign vs malignant compression fractures of the spine.	The correct interpretation between 2 neuroradiologists was 77% and 95%. The combined sensitivity rate was 88.5%, and the specificity rate was 89.5%. MRI reliably distinguished benign vs malignant lesions based on the anatomic distribution and intensity of signal changes of bone and adjacent tissues, contrast enhancement characteristics, and changes over time.	2
29. Bartlett RJ, Hill CA, Devlin R, Gardiner ED. Two-dimensional MRI at 1.5 and 0.5 T versus CT myelography in the diagnosis of cervical radiculopathy. *Neuroradiology.* 1996;38(2):142-147.	Review/Other-Dx	23 patients	A prospective comparison of standard 2D MRI sequences, at both high and midfield strength, with CT myelography.	MRI is adequate for assessment of cord compression, where high field strength is superior to midfield strength. MRI using 4 mm sections is inadequate for presurgical assessment of root compression. It remains to be proven whether thin-section white-CSF volume sequences or Gd-enhanced volume studies can replace CT myelography.	4
30. Baskaran V, Pereles FS, Russell EJ, et al. Myelographic MR imaging of the cervical spine with a 3D true fast imaging with steady-state precession technique: initial experience. *Radiology.* 2003;227(2):585-592.	Observational-Dx	30 consecutive patients	To compare a 3D true FISP sequence with 3D spoiled gradient-recalled-echo sequence for MRI evaluation of the cervical spine in the transverse plane.	Overall, uncorrected contrast-to-noise ratio was significantly greater for true FISP than for conventional gradient-recalled-echo imaging ($t = 12.73$, $df = 89$, $P<.0001$ [Bonferroni correction used]). 3D MRI with a true FISP technique provides enhanced myelographic effect, high structural definition, and excellent tissue contrast compared with those of a conventional 3D spoiled gradient-recalled-echo technique. Additionally, the true FISP sequence is fast and relatively insensitive to CSF pulsation.	3
31. Demir A, Ries M, Moonen CT, et al. Diffusion-weighted MR imaging with apparent diffusion coefficient and apparent diffusion tensor maps in cervical spondylotic myelopathy. *Radiology.* 2003;229(1):37-43.	Experimental-Dx	36 patients	To evaluate DWI MRI in patients with cervical spondylosis and/or myelopathy.	DWI ADC maps had a sensitivity of 80% while T2-weighted images had a sensitivity of 61%. The NPV was 63% and 60% for ADC maps and T2-weighted images, respectively. DWI improved the sensitivity of imaging in CSM.	1
32. Emery SE. Cervical spondylotic myelopathy: diagnosis and treatment. *J Am Acad Orthop Surg.* 2001;9(6):376-388.	Review/Other-Dx	N/A	To review diagnostic patterns of CSM.	Diagnosis can usually be made on the basis of findings from the history, physical examination, and plain radiographs, but confirmation by MRI or CT and myelography is necessary.	4

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
33. Heldmann U, Myschetzky PS, Thomsen HS. Frequency of unexpected multifocal metastasis in patients with acute spinal cord compression. Evaluation by low-field MR imaging in cancer patients. *Acta Radiol.* 1997;38(3):372-375.	Review/Other-Dx	240 patients	To estimate, in an acute care service, the frequency of multiple-level lesion involvement in patients with clinically suspected spinal cord compression or spinal blockage.	In 65 (27%) of the 240 patients, involvement of at least 1 level was found. Of these patients, 32 (49%) showed involvement of more than 1 level. This high rate was surprising, since only 14 (44%) of the 32 multiple lesions had been clinically suspected. There was no correlation to age or original type of cancer. MRI accurately demonstrates the anatomy of the spine and spinal cord, showing the level and complexity of spinal lesions.	4
34. Nagata K, Ohashi T, Abe J, Morita M, Inoue A. Cervical myelopathy in elderly patients: clinical results and MRI findings before and after decompression surgery. *Spinal Cord.* 1996;34(4):220-226.	Review/Other-Dx	173 patients	To evaluate clinical results and MRI findings before and after decompression surgery.	Functional assessment used was according to the JOA score (the higher the better), and the imaging outcome was assessed by a midline sagittal MRI assigned to 3 categories either for restoration of cord morphology, improvement or unchanged. Patients were followed up for between 1 and 4 1/2 years. Older patients were likely to have more levels, and higher levels affected, and as a result were more likely to require a posterior operation. The recovery rate after an anterior operation was the same as that after a posterior operation. The pre- and post-operative JOA scores were higher in younger patients who tended to have milder disease with fewer levels affected. The patients did better if the cord morphology was restored to normal, and this was easier to achieve in younger patients who had fewer levels involved and had less cord distortion preoperatively.	4
35. Papadopoulos CA, Katonis P, Papagelopoulos PJ, Karampekios S, Hadjipavlou AG. Surgical decompression for cervical spondylotic myelopathy: correlation between operative outcomes and MRI of the spinal cord. *Orthopedics.* 2004;27(10):1087-1091.	Observational-Dx	42 patients	To evaluate whether the different appearances of intramedullary high-signal intensity on T2-weighted MRI are related to the surgical prognosis.	MRI signal intensities were classified as type 0 if no intramedullary high-signal intensity on T2-weighted images was noted. Type 1 if high-signal intensity involved only 1 segment. Type 2 if high-signal intensity extended over 2 segments. Statistical analyses of the recovery ratio showed that type 0 and type 1 intramedullary high-signal intensity indicates better prognosis than type 2.	2

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
36. Puzzilli F, Mastronardi L, Ruggeri A, Lunardi P. Intramedullary increased MR signal intensity and its relation to clinical features in cervical myelopathy. *J Neurosurg Sci.* 1999;43(2):135-139; discussion 139.	Observational-Dx	100 patients	To evaluate intramedullary increased MR signal intensity and its relation to clinical features in cervical myelopathy.	Statistical analysis demonstrated that intramedullary hyperintensity is most frequently associated with severe impairment of deambulation, muscular hypotonus-hypotrophy and hypoesthesias of the upper limbs. These radiological findings probably correspond to various types of lesions which, when irreversible, may influence postoperative neurological recovery.	3
37. Suri A, Chabbra RP, Mehta VS, Gaikwad S, Pandey RM. Effect of intramedullary signal changes on the surgical outcome of patients with cervical spondylotic myelopathy. *Spine J.* 2003;3(1):33-45.	Observational-Dx	146 consecutive patients	To determine the radiographic and clinical factors that correlate with the prognosis after surgery in patients with CSM and to investigate the factors affecting the outcome of intramedullary signal changes on MRI.	Patients with no intramedullary signal changes and signal changes only on T2-weighted images had a better outcome than patients with signal changes on both T1- and T2-weighted images. The presence of intramedullary signal changes on T1- as well as T2-weighted sequences on MRI in patients with CSM indicates a poor prognosis. However, the T2 signal intensity changes reflect a broad spectrum of spinal cord reparative potentials. Predictors of surgical outcomes are preoperative signal intensity change patterns of the spinal cord and their postoperative persistence/regression on radiological evaluations, age at the time of surgery, multiplicity of involvement and chronicity of the disease and surgical approach (anterior/posterior).	3

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
38. Arvin B, Kalsi-Ryan S, Karpova A, et al. Postoperative magnetic resonance imaging can predict neurological recovery after surgery for cervical spondylotic myelopathy: a prospective study with blinded assessments. *Neurosurgery*. 2011;69(2):362-368.	Observational-Dx	52 patients	To investigate whether findings on MRI at 6 months postoperatively could predict recovery at 1 year in CSM patients.	Using univariate analysis, patients whose cord failed to re-expand had poorer outcome according to the modified JAO score and Nurick score (*P*=.014) and grip test (*P*=.006) postoperatively. Stepwise multivariate regression showed lack of cord re-expansion to be predictive of prognosis postoperatively in the modified JAO score (*P*=.013) and Berg Balance Scale (*P*=.014), and walking test (*P*=.011). Postoperative hyperintense T2 signal change was predictive of worse outcome on the Berg Balance Scale (*P*=.014) and walking test (*P*=.020), Nurick score (*P*=.001), and Short Form-36 scores (*P*=.020). In cases in which the T2 signal intensified, there was a poorer outcome on Nurick scores (*P*=.013), grip test (*P*=.017), and Short Form-36 scores (*P*=.030).	2
39. Avadhani A, Rajasekaran S, Shetty AP. Comparison of prognostic value of different MRI classifications of signal intensity change in cervical spondylotic myelopathy. *Spine J.* 2010;10(6):475-485.	Observational-Dx	35 patients	To determine the MRI classification of signal intensity changes in patients with CSM that is useful for prognostication of surgical outcome.	Preoperative MRI studies demonstrated the following: Grade 0=1, Grade 1=13, Grade 2=13; focal=18, multisegmental=16; Group A=1; Group B=29; and Group C=5. Resolution of signal changes in T2WI was seen in most patients; however, 4 patients developed low SI in T1WI in the postoperative MRI. There was no significant difference in the recovery rates of patients with different grades in the T2WI or with focal or multisegmental SI changes (*P*=.47 and .28, respectively). In contrast, patients with low SI changes in T1WI were associated with a poor surgical outcome (*P*<.001). The linear regression model performed using low-intensity signal changes as a dependent variable and the recovery rate as an independent variable confirmed the significance (*P*<.001) of low SI changes on T1WI as a predictor for surgical outcome.	3

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
40. Eck JC, Drew J, Currier BL. Effects of magnetic resonance imaging signal change in myelopathic patients: a meta-analysis. *Spine (Phila Pa 1976).* 2010;35(23):E1306-1309.	Meta-analysis	16 studies: 886 patients; 659 with MRI signal change, and 227 without MRI signal change	Meta-analysis of data to determine the effect of MRI signal change on preoperative and postoperative JOA scores and on recovery rate after surgery.	Preoperative and postoperative JOA scores and the recovery rates were significantly better in patients without MRI signal changes (P<0.05). The mean preoperative JOA scores were 10.63 and 11.37 for patients with and without MRI signal changes, respectively. The mean postoperative JOA scores were 13.37 and 14.19 for patients with and without MRI signal changes, respectively. The mean recovery rates were 43.87% and 49.31% for patients with and without MRI signal changes, respectively.	M
41. Karpova A, Arun R, Davis AM, et al. Reliability of quantitative magnetic resonance imaging methods in the assessment of spinal canal stenosis and cord compression in cervical myelopathy. *Spine (Phila Pa 1976).* 2013;38(3):245-252.	Experimental-Dx	17 patients	To assess the intra- and interobserver reliability of commonly used quantitative MRI measures such as transverse area of spinal cord, compression ratio (CR), maximum canal compromise, and maximum spinal cord compression.	The mean +/- standard deviation for intraobserver intraclass correlation coefficient was 0.88 +/- 0.1 for maximum canal compromise, 0.76 +/- 0.08 for maximum spinal cord compression, 0.92 +/- 0.07 for transverse area, and 0.82 +/- 0.13 for compression ratio. In addition, the interobserver intraclass correlation coefficient was 0.75 +/- 0.04 for maximum canal compromise, 0.79 +/- 0.09 for maximum spinal cord compression, 0.80 +/- 0.05 for compression ratio, and 0.86 +/- 0.03 for transverse area. Higher degree of canal compromise (maximum canal compromise) was associated with lower modified version of JAO score (P=0.05). Also, a strong association was found between maximum spinal cord compression and lower modified version of JAO score, greater number of steps, and longer walking time (P<0.05).	1
42. Li F, Chen Z, Zhang F, Shen H, Hou T. A meta-analysis showing that high signal intensity on T2-weighted MRI is associated with poor prognosis for patients with cervical spondylotic myelopathy. *J Clin Neurosci.* 2011;18(12):1592-1595.	Observational-Dx	75 patients	Retrospective study to determine the sensitivity and specificity of MR in (a) detecting maximum canal compromise using complete myelography, clinical follow-up, surgical findings and autopsy as the gold standard, and (b) distinguishing malignant from benign compression fracture of vertebrae.	The sensitivity is 93%, the specificity 97% and the overall accuracy 95%. The signal intensity measured in the sagittal MRIs of a collapsed vertebral body is divided by that of an average of 3 adjacent normal vertebrae to form a SIR. The SIRs of 41 metastatic and 15 post-traumatic collapsed vertebrae are calculated. A ratio of 0.8 has the most differentiating power. All benign and 1 malignant compressed vertebrae have SIRs greater than 0.8.	3

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
43. Machino M, Yukawa Y, Ito K, et al. Can magnetic resonance imaging reflect the prognosis in patients of cervical spinal cord injury without radiographic abnormality? *Spine (Phila Pa 1976).* 2011;36(24):E1568-1572.	Review/Other-Dx	100 patients	To investigate the occurrence rate of intramedullary high-signal intensity (ISI and prevertebral hyperintensity) in patients with SCI without radiographic abnormality, and examine their relationship to symptom severity and surgical outcome.	ISI was observed in 92 patients and prevertebral hyperintensity in 90 patients on MRI preoperatively. The range of ISI and prevertebral hyperintensity tended to increase with scores on the preoperative ASIA scale. ISI and prevertebral hyperintensity were seen in all patients with ASIA A and B. There was a significant negative correlation between the range of ISI and preoperative JOA score. A significant negative correlation between the range of ISI and recovery rate of JOA score was also seen.	4
44. Ozawa H, Sato T, Hyodo H, et al. Clinical significance of intramedullary Gd-DTPA enhancement in cervical myelopathy. *Spinal Cord.* 2010;48(5):415-422.	Review/Other-Dx	683 patients	To clarify the significance of intramedullary Gd-DTPA enhancement in cervical myelopathy, the prevalence, morphologic features, clinical relevance and postoperative change were investigated.	Intramedullary enhancement was observed in 50 cases (7.3%). The enhancements were observed between the most severely compressed disc and the cranial half of the lower vertebral body. On axial images, they were observed at the posterior or posterolateral periphery of the spinal cord. Enhancement areas were observed within T2 high-intensity areas and smaller than them. The preoperative JOA score was 9.8 +/- 2.8 points in the enhancement group and 9.8 +/- 3.3 points in the nonenhancement group (NS). The postoperative JOA score was 12.7 +/- 2.9 points in the enhancement group and 14.2 +/- 2.4 in the nonenhancement group (P=0.006). Intramedullary enhancement disappeared in 60% of the patients 1 year after surgery.	4
45. Sato T, Horikoshi T, Watanabe A, et al. Evaluation of cervical myelopathy using apparent diffusion coefficient measured by diffusion-weighted imaging. *AJNR Am J Neuroradiol.* 2012;33(2):388-392.	Observational-Dx	66 patients	To investigate the hypothesis that ADC measured by DWI of the spinal cord can provide objective and reliable indications of the severity of CSM, by evaluating the relationship between ADC values and other clinical factors.	ADC values in the spinal cord significantly increased with the degree of spinal cord compression and decreased with time after decompression surgery. Patients with higher ADC values had lower preoperative JOA scores and tended to show poorer clinical recovery.	2

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
46. Shin JJ, Jin BH, Kim KS, Cho YE, Cho WH. Intramedullary high signal intensity and neurological status as prognostic factors in cervical spondylotic myelopathy. *Acta Neurochir (Wien).* 2010;152(10):1687-1694.	Review/Other-Dx	137 patients	To clarify the factors in prognosis, the authors prospectively analyzed the outcomes of patients with myelopathy caused by soft disc herniation in correlation with MRI findings and other clinical parameters.	The mean preoperative and postoperative JOA scores were 10.5 +/- 2.9 and 14.9 +/- 2.1, respectively ($P<0.05$). The mean recovery rate based on the JOA score was 70.0 +/- 20.1%. The respective preoperative JOA scores and recovery ratios(%) were 11.6 +/- 2.3 and 81.5 +/- 17.0% in 20 patients with signal intensity grade 0; 10.8 +/- 2.3 and 70.1 +/- 17.3% in 25 patients with grade 1; and 9.2 +/- 3.6 and 60.7 +/- 20.9% in 25 patients with grade 2, respectively. Post-surgical neurological outcome showed no significant relationship to age, symptom duration, cervical alignment, stenosis, or cord compression.	4
47. Vedantam A, Jonathan A, Rajshekhar V. Association of magnetic resonance imaging signal changes and outcome prediction after surgery for cervical spondylotic myelopathy. *J Neurosurg Spine.* 2011;15(6):660-666.	Review/Other-Dx	197 patients	To determine whether the type of ISI was an independent predictor of outcome following central corpectomy in patients with CSM or ossification of the posterior longitudinal ligament.	There were 30 patients (15.2%) with Type 0, 104 patients (52.8%) with Type 1, and 63 patients (32%) with Type 2 ISI on MRIs. Age, duration of symptoms, and preoperative Nurick grade were similar among the groups. A preoperative Nurick grade of 4 or 5 (OR 0.23, $P<0.001$) and presence of Type 2 ISI on T2-weighted images (OR 0.48, $P=0.04$) negatively influenced the probability of cure after surgery. Hypointensity on T1-weighted images was only seen in patients who had Type 2 ISI changes. Among the 63 patients with Type 2 ISI, the presence of T1-weighted hypointensity (16 patients) was found to negatively impact cure (OR 0.1, $P=0.04$).	4
48. Aota Y, Niwa T, Uesugi M, Yamashita T, Inoue T, Saito T. The correlation of diffusion-weighted magnetic resonance imaging in cervical compression myelopathy with neurologic and radiologic severity. *Spine (Phila Pa 1976).* 2008;33(7):814-820.	Observational-Dx	100 patients	A retrospective evaluation to correlate high signal intensity on ADC maps and T2-weighted images to neurologic severity and radiologic spinal cord compression in patients with cervical compression myelopathy. 32 patients Type I without signal change on either ADC maps or T2-weighted images. 33 patients Type II with high signal intensity only on the ADC map. 28 patients Type III with high signal intensity on both the ADC map and the T2-weighted images. 7 patients Type IV with high signal intensity only on T2-weighted images.	The degree of canal compression and the JOA scores were significantly different among the 4 groups ($P<0.005$). Most type III (25/28) and type IV (7/7) patients had severe cord compression. Average JOA scores in each type were (I) 16.0, (II) 14.7, (III) 11.7, and (IV) 8.7. ADC maps demonstrated internal changes in the early stages of chronic spinal cord compression, but had limitations for the detection of intramedullary changes in late-stage myelopathy.	2

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
49. van Hecke W, Nagels G, Emonds G, et al. A diffusion tensor imaging group study of the spinal cord in multiple sclerosis patients with and without T2 spinal cord lesions. *J Magn Reson Imaging.* 2009;30(1):25-34.	Observational-Dx	42 total subjects, 21 healthy subjects, 11 MS patients with spinal cord lesions, 10 MS patients without spinal cord lesions	To examine the T2-normal appearing spinal cord of patients with MS using DTI.	It was observed that the FA, the transverse diffusivity lambda (perpendicular), and the ratio of the longitudinal and transverse diffusivities (lambda (parallel)/lambda (perpendicular)) were significantly lower in the spinal cord of MS patients with spinal cord lesions compared with the control subjects using both the ROI method (P=0.014, P=0.028, and P=0.039, respectively) and the tractography-based approach (P=0.006, P=0.037, and P=0.012, respectively). For both image analysis methods, the FA and the lambda (parallel)/lambda (perpendicular) values were significantly different between the control group and the MS patient group without T(2) spinal cord lesions (P=0.013). The results suggest that the spinal cord may still be affected by MS, even when lesions are not detected on a conventional MR scan. In addition, we demonstrated that diffusion tensor tractography is a robust tool to analyze the spinal cord of MS patients.	3
50. Goto S, Mochizuki M, Watanabe T, et al. Long-term follow-up study of anterior surgery for cervical spondylotic myelopathy with special reference to the magnetic resonance imaging findings in 52 cases. *Clin Orthop Relat Res.* 1993(291):142-153.	Review/Other-Dx	151 patients	To evaluate the role of MRI in progressive spondylotic myelopathy.	A disturbing incidence of progression of myelopathy was noted 10 years after surgery. MRI identified many of the causes (eg, newly developed intervertebral disk herniation and progression of spondylosis associated with spinal malalignment in both cephalad and caudal directions). Other adverse changes were hypertrophy of the yellow ligament and ossification of the posterior longitudinal ligament. The new and improved techniques consist of decompression to a width of 16 mm or more with intraoperative US in addition to extirpation of the posterior longitudinal ligament. This new measure may reduce the incidence of late neurologic deterioration.	4

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
51. Isoda H, Ramsey RG. MR imaging of acute transverse myelitis (myelopathy). *Radiat Med.* 1998;16(3):179-186.	Review/Other-Dx	26 patients	To retrospectively review the MRI characteristics of ATM.	MRI in 8/16 lesions in 9 subjects with preexisting MS showed multiple areas of ISI on T2-weighted sagittal images, and 11 lesions had no cord swelling. 12/16 lesions showed heterogeneous enhancement. MRI in 10/13 lesions in 12 subjects with preexisting HTLV-1 infection, mycoplasma pneumonia infection, hepatitis B vaccinations, and uncertain etiologies revealed fusiform ISI areas on T2-weighted sagittal images and cord swelling. 7/11 lesions in the patients who underwent injection of contrast medium showed heterogeneous enhancement, whereas others showed no enhancement. MRI is recommended for the evaluation of ATM.	4
52. Morio Y, Yamamoto K, Kuranobu K, Murata M, Tuda K. Does increased signal intensity of the spinal cord on MR images due to cervical myelopathy predict prognosis? *Arch Orthop Trauma Surg.* 1994;113(5):254-259.	Review/Other-Dx	25 patients	To evaluate clinical significance of high T2 signal in compressive myelopathy.	There was no significant relationship between spinal cord compressive change and clinical symptoms. Patients in whom the high signal change of the spinal cord on T2-weighted sequence recovered after decompressive surgery had better recovery from clinical symptoms, but a statistical significance was not found. It is suggested that signal changes on T2-weighted images may reflect pathological changes but cannot be used to predict prognosis at present.	4

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
53. Penning L, Wilmink JT, van Woerden HH, Knol E. CT myelographic findings in degenerative disorders of the cervical spine: clinical significance. *AJR Am J Roentgenol.* 1986;146(4):793-801.	Review/Other-Dx	80 patients	To evaluate CT myelopathy signs vs clinical signs.	Concentric compression of the cord in a narrow (stenotic) canal (group 2) proved to produce long tract signs only after the cross-sectional area of the cord had been reduced by about 30% to a value of about 60 mm2 or less. In most cases, nerve-root swelling (group 3) coincided with the side of nerve-root symptoms. A 100% correlation was found between the side of disk herniation with occlusion of the corresponding foramen (group 4) and the side of nerve-root symptoms. In 24 patients, cord and nerve roots showed no abnormalities (group 5). If stenosis of the spinal canal, nerve root swelling, and disk herniation are considered specific CT myelographic signs in nerve-root symptomatology, a specific diagnosis could be made in about 40% of the cases.	4
54. Lowe LH, Johanek AJ, Moore CW. Sonography of the neonatal spine: part 2, Spinal disorders. *AJR Am J Roentgenol.* 2007;188(3):739-744.	Review/Other-Dx	N/A	To focus on key imaging features of common skin-covered spinal anomalies (spina bifida occulta) and to distinguish them from normal variants (previously discussed in part 1).	Modern imaging technology allows accurate neonatal spinal sonographic screening and the characterization of spinal abnormalities within the first few days of life. It is useful to determine the type of lesion present and to guide the type and timing of therapy.	4
55. Lowe LH, Johanek AJ, Moore CW. Sonography of the neonatal spine: part 1, Normal anatomy, imaging pitfalls, and variations that may simulate disorders. *AJR Am J Roentgenol.* 2007;188(3):733-738.	Review/Other-Dx	N/A	To discuss neonatal spine sonography with emphasis on imaging pitfalls and normal variants that may simulate disease and to distinguish them from true spinal disorders.	Sonography of the neonatal spine is now accepted as a highly sensitive, readily available screening study that can be used to evaluate various anomalies of the lumbar spine in most infants younger than 4 months.	4

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
56. Costa F, Tomei M, Sassi M, et al. Evaluation of the rate of decompression in anterior cervical corpectomy using an intra-operative computerized tomography scan (O-Arm system). *Eur Spine J.* 2012;21(2):359-363.	Review/Other-Dx	187 patients	To evaluate the efficacy of intra-operative CT scanning in the analysis of bone removal accuracy during anterior cervical corpectomy, in order to allow any necessary immediate correction in the event of inadequate bone removal.	Out of a population of 187 patients admitted to our department, with a diagnosis of myelopathy due to spondylotic degenerative cervical stenosis, 15 patients underwent a surgical treatment with anterior cervical corpectomy and fusion. There were 9 males (60%) and 6 females (40%); the mean age was 52.4 years, ranging from 41 to 57 years. The preoperative radiologic investigations (MRI and CT scans) revealed in the 9 patients (60%) the extent of the compression to 1 vertebral body (C4 - 1 case, C5 - 4 cases, C6 - 4 cases), while in the 6 cases (40%) the compression regarded 2 vertebral body (C3 and C4 - 1 case, C4 and C5 - 2 cases, C5 and C6 - 3 cases). During surgery, when the decompression was judged completely, a CT scan was performed: in 11 cases (73.3%) the decompression was considered adequate, while in 4 cases (26.7%) it was deemed insufficient and the surgical strategy was changed in order to optimize the bone removal. In these cases an additional scan was taken to prove the efficacy of decompression, achieved in all patients.	4
57. Hecht AC, Koehler SM, Laudone JC, Jenkins A, Qureshi S. Is intraoperative CT of posterior cervical spine instrumentation cost-effective and does it reduce complications? *Clin Orthop Relat Res.* 2011;469(4):1035-1041.	Review/Other-Dx	87 patients	To document the incidence of hardware-related complications and evaluate cost-effectiveness when using intraoperative 3D fluoroscopy CT in posterior cervical spine surgery.	7 patients (8%) had screws changed based on the results of the 3D fluoroscopy: 0.5% of lateral mass screws, 3.1% of thoracic pedicle screws, and 15% of C2 pars screws. No patients who had evaluation of hardware with the intraoperative 3D fluoroscopy CT required a return to surgery for complications secondary to hardware failure, malposition, or cutout.	4

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
58. Mok CC, Lau CS, Chan EY, Wong RW. Acute transverse myelopathy in systemic lupus erythematosus: clinical presentation, treatment, and outcome. *J Rheumatol.* 1998;25(3):467-473.	Observational-Dx	315 total systemic lupus erythematosus patients studied; 10 cases of ATM	The clinical presentation, autoantibody profile, treatment, and outcome of cases of ATM in our local systemic lupus erythematosus population were retrospectively analyzed and compared with systemic lupus erythematosus controls.	CSF abnormalities were present in 63% of the patients, while MRI of the spinal cord revealed abnormal T2 signals in 56%. ATM was not associated with antiribosomal P, anti-extractable nuclear antigen, or antiphospholipid antibodies. Systemic complement activation was not evident in most patients during the acute phase of myelitis. Early aggressive therapy using a combination of corticosteroid and cytotoxic agents is associated with a satisfactory outcome. Further prospective study is needed to delineate the best treatment and its efficacy in the prevention of relapses.	3
59. Papadopoulos A, Gouliamos A, Trakadas S, et al. MRI in the investigation of patients with myelopathy thought to be due to multiple sclerosis. *Neuroradiology.* 1995;37(5):384-387.	Review/Other-Dx	65 patients	To investigate the role of cerebral and spinal cord MRI.	Cerebral MRI demonstrated lesions compatible with demyelination in 80% and spinal cord MRI in 68.6%. In 28.5% of patients brain lesions were present with normal spinal cord images, but in 17%, spinal cord lesions were depicted with a normal brain MRI. The combination of the 2 examinations demonstrated lesions in 97% of the patients. The frequency of coexistent cerebral lesions in patients with spinal cord lesions was over 85% in patients with chronic disease but only 28.5% in patients with acute myelitis.	4
60. Bermel RA, Rae-Grant AD, Fox RJ. Diagnosing multiple sclerosis at a later age: more than just progressive myelopathy. *Mult Scler.* 2010;16(11):1335-1340.	Review/Other-Dx	111 patients	A review of patients diagnosed at age 60 or over, with particular emphasis on patients who continue to have evidence of active inflammation despite a later onset.	At the time of diagnosis, 8% of patients had a clinically isolated syndrome, 33% were in the relapsing-remitting stage, while 23% had a secondary progressive course, and 32% were primary progressive. 88% of patients had a brain MRI judged 'typical for MS', and 32% of all patients receiving gadolinium had enhanced lesions. 46% of patients with relapsing-remitting MS or clinically isolated syndrome exhibited gadolinium enhancement. Myelitis was the most common initial clinical syndrome, and progressive myelopathy was a common but not exclusive clinical syndrome at the time of diagnosis.	4

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
61. Muralidharan R, Saladino A, Lanzino G, Atkinson JL, Rabinstein AA. The clinical and radiological presentation of spinal dural arteriovenous fistula. *Spine (Phila Pa 1976).* 2011;36(25):E1641-1647.	Review/Other-Dx	153 patients	To assess the symptoms, neurologic signs, and radiologic findings in a large series of patients with myelopathy due to spinal dural arteriovenous fistula.	Mean age was 63.5 years and 119 (77.8%) were men. Weakness and sensory changes are usually symmetric and ascend from the lower extremities. Presenting symptoms included leg weakness (74 patients, 48.4%), leg sensory disturbances (41 patients, 26.8%), pain involving back or legs (31 patients, 20.3%), and sphincter disturbances (6 patients, 3.9%). Worsening weakness with exertion was present in 66 (43.1%) patients and correlated with thoracic fistula location (P=0.04). Pinprick level was identified in 57 (37.3%) patients; L1 level (22.8%) was the most common, followed by T10 (19.3%). Fistula level (+/-2 levels) corresponded to pinprick level in only 40% of these patients. T2 signal abnormality involved the conus in 95% of our patients. Highest cord level of T2 signal hyperintensity (+/-2 levels) corresponded to pinprick level in 25% of cases.	4
62. Robertson CE, Brown RD, Jr., Wijdicks EF, Rabinstein AA. Recovery after spinal cord infarcts: long-term outcome in 115 patients. *Neurology.* 2012;78(2):114-121.	Review/Other-Dx	115 patients	To investigate the long-term outcome of patients with SCI and identify prognostic predictors.	A total of 45% of infarcts were perioperative (69% aortic surgeries). A total of 68% reached maximal deficit within 1 hour (mean = 5 hours). Impairment at nadir was ASIA A 23%, B 26%, C 14%, and D 37%. A total of 75/93 (81%) patients studied with MRI had cord signal abnormality. At nadir, 81% required wheelchair, 86% required catheterization, and 32% had pain. At last follow-up (mean = 3 years), 23% had died. Among survivors, 42% required a wheelchair, 54% required catheterization, and 29% had pain upon last follow-up. Of 74 patients using a wheelchair at hospital dismissal, 41% were walking by final follow-up. Of 83 patients catheterized at dismissal, 33% were catheter-free at last follow-up. Older age (P<0.0001), increased severity of impairment at nadir (P=0.02), and peripheral vascular disease (P=0.003) were independent risk factors for mortality. Severe impairment (ASIA A/B) at nadir predicted wheelchair use (P<0.0001) and bladder catheterization (P<0.0001) at last follow-up.	4

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
63. Romi F, Naess H. Characteristics of spinal cord stroke in clinical neurology. *Eur Neurol.* 2011;66(5):305-309.	Review/Other-Dx	32 patients	To review characteristics of spinal cord stroke in clinical neurology.	28 patients had infarctions, 3 had hemorrhages, and 1 had arterio-venous fistula. 28 spinal cord strokes were spontaneous, 2 were secondary to aorta aneurysms, and 2 post surgery. Biphasic ictus was seen in 17% of all spontaneous infarctions. Younger age, male gender, hypertension, diabetes mellitus, and higher blood glucose on admission regardless of diabetes mellitus, were risk factors associated with more severe spinal cord stroke.	4
64. Toossi S, Josephson SA, Hetts SW, et al. Utility of MRI in spinal arteriovenous fistula. *Neurology.* 2012;79(1):25-30.	Observational-Dx	31 patients	To determine the sensitivity and specificity of MRI in the diagnosis spinal arteriovenous fistula and characterize its radiographic features.	The authors identified 36 cases of spinal arteriovenous fistula (median age 56, 67% male) and 32 controls (median age 54, 44% male). MRI was sensitive in identifying spinal arteriovenous fistula as the primary diagnosis in 94% (radiologist A, 95% confidence interval 0.87–1.02) and 89% (radiologist B, 95% confidence interval 0.79–0.99) of cases. The sensitivity of spinal cord T2 hyperintensity or flow voids was 100% and the specificity of T2 hyperintensity and flow voids was 97%.	3
65. Atkinson JL, Miller GM, Krauss WE, et al. Clinical and radiographic features of dural arteriovenous fistula, a treatable cause of myelopathy. *Mayo Clin Proc.* 2001;76(11):1120-1130.	Review/Other-Dx	94 total patients: 87 MRI, 37 CT myelography	A retrospective review to assess presentation, imaging, treatment, and outcome of patients with myelopathy due to a dural arteriovenous fistula.	MRI confirmed the diagnosis in 86 patients; CT myelography was needed to confirm the fistula in 1 patient. Spinal angiography detected the fistula in all patients. The diagnosis of a dural arteriovenous fistula seems to be delayed considerably because dural arteriovenous fistula is not included in the differential diagnosis of myelopathy and because of clinicians' unfamiliarity with suggestive or revealing findings on diagnostic imaging. Neurodiagnostic imaging confirms the diagnosis, and spinal angiography localizes the fistula. Surgical intradural disconnection of the dural arteriovenous fistula clinically reverses the pathophysiology. Additionally, surgical treatment is associated with low short-term morbidity, no permanent morbidity, and no mortality. If the diagnosis is made early and treatment initiated in such patients, they generally do well.	3

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
66. Si-jia G, Meng-wei Z, Xi-ping L, et al. The clinical application studies of CT spinal angiography with 64-detector row spiral CT in diagnosing spinal vascular malformations. *Eur J Radiol.* 2009;71(1):22-28.	Observational-Dx	17 patients	To explore the value of CT spinal angiography with 64-detector row spiral CT in diagnosing spinal vascular malformations.	The statistical analysis of the diagnostic results by the 3 experienced neuroradiologists had no statistical difference ($P>0.05$). All of the 17 patients showed clearly the abnormality of spinal cord vessels and the range of lesions by CT spinal angiography. Among them, 1 patient was diagnosed as arteriovenous fistulas by MRI and CT spinal angiography, which was verified by surgical operation. DSA of the same patient, however, did not visualize the lesion. One case was diagnosed as arteriovenous malformations complicated with arteriovenous fistulas by DSA, but CT spinal angiography could only show arteriovenous malformations not arteriovenous fistulas. The type differentiations of all the other 16 patients were consistent with DSA results. For 13 cases with positive CT spinal angiography results, DSA displayed 20 feeding vessels, among which 16 vessels were displayed correctly by CT spinal angiography, 4 could not be visualized, and 2 turned out to be false-positive. Fistulas were not displayed in 6 cases by CT spinal angiography. Draining veins were displayed clearly in all cases, which agreed with DSA results. 4 cases who took contrast-enhanced-MRA obtained the same type diagnosis as that from CT spinal angiography. Feeding arteries were not displayed in contrast-enhanced-MRA of 1 case, but could be clearly visualized in other 3 cases, and the results agreed with CTA and DSA results. Fistulas could be seen in 2 cases. Draining veins and the disease range could be displayed distinctly by 3D contrast-enhanced-MRA.	1

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
67. Karnaze MG, Gado MH, Sartor KJ, Hodges FJ, 3rd. Comparison of MR and CT myelography in imaging the cervical and thoracic spine. *AJR Am J Roentgenol.* 1988;150(2):397-403.	Review/Other-Dx	38 patients	To compare MRI and CT myelography in a retrospective study.	MR was equal or superior to CT myelography in depicting cases of cord enlargement, cord compression, and cord atrophy, providing better tissue characterization, no shoulder artifact, and no limitation caused by CSF block. CT myelography was superior to MR in depicting cases of spondylosis and arachnoiditis. It showed superior spatial resolution, which was most pronounced when comparing axial images and hence particularly superior in detecting the lateral extent of disk herniation. Use of surface coils and thin imaging sections is essential for accurate and complete MR evaluation of the cervical and thoracic spine.	4
68. Hetts SW, Moftakhar P, English JD, et al. Spinal dural arteriovenous fistulas and intrathecal venous drainage: correlation between digital subtraction angiography, magnetic resonance imaging, and clinical findings. *J Neurosurg Spine.* 2012;16(5):433-440.	Observational-Dx	31 patients	To assess the relationship between the craniocaudal extent of dilated intrathecal veins draining spinal dural arteriovenous fistulas and the degree of patient functional disability to gain greater insight into the pathophysiology of vascular myelopathy.	Enlargement of the intrathecal draining veins averaged 10 +/- 7.7 spinal levels on DSA. Patients with enlarged draining veins extending 10 or more spinal levels on DSA had worse Aminoff-Logue scale scores (mean gait 3.4, mean micturition 1.5) than patients with draining veins extending fewer than 10 levels (mean gait 1.8, mean micturition 0.6; P=0.009 and 0.02, respectively). The number of vertebral body levels of enlarged draining veins correlated with the Aminoff-Logue scale score (gait r = 0.42, P=0.009; and micturition r = 0.55, P=0.0006). More extensive enlarged draining veins were associated with more spinal cord T2 hyperintensity, T2 intrathecal flow voids, and T1 vessel enhancement but not cord enhancement.	3

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
69. Krings T, Geibprasert S. Spinal dural arteriovenous fistulas. *AJNR Am J Neuroradiol.* 2009;30(4):639-648.	Review/Other-Dx	N/A	To review the epidemiology, etiology, clinical and imaging features, and therapeutic approaches of spinal dural arteriovenous fistulas.	Spinal dural arteriovenous fistulas are a rare but treatable cause of otherwise progressive paraplegia. The neuroradiologist plays a major role in the detection of these lesions and in their treatment, which should be aimed at occluding the proximal portion of the vein together with the distal arterial segment. Neurologic symptoms are unspecific; however, the MR imaging trias of cord edema, perimedullary vessels, and contrast enhancement of the cord in elderly men should lead to the diagnosis, which should be confirmed by selective DSA, preferably following guidance toward the fistula localization by contrast-enhanced MRA.	4
70. Mull M, Nijenhuis RJ, Backes WH, Krings T, Wilmink JT, Thron A. Value and limitations of contrast-enhanced MR angiography in spinal arteriovenous malformations and dural arteriovenous fistulas. *AJNR Am J Neuroradiol.* 2007;28(7):1249-1258.	Review/Other-Dx	34 patients	To study the validity of MRA for identification of spinal arteriovenous abnormalities.	DSA revealed spinal dural arteriovenous fistulas in 20 abnormalities of which 19 were spinal and 1 was tentorial with spinal drainage, as well as spinal arteriovenous malformations in 11 patients. In 3 patients, MRA and DSA were both normal. For detection of spinal arteriovenous abnormalities, neither false-positive nor false-negative MRA results were obtained. The MRA-derived level of the feeding artery in spinal dural arteriovenous fistulas agreed with DSA in 14/19 cases. In 5 cases, a mismatch of 1 vertebral level (not side) was noted for the feeding artery. For the tentorial arteriovenous fistulas, only the spinal drainage was depicted; the feeding artery was outside the MRA field of view. In intradural spinal arteriovenous malformations, the main feeding artery was identified by MRA in 10/11 patients. MRA could differentiate between glomerular and fistulous spinal arteriovenous malformations in 4/6 cases and between sacral spinal dural arteriovenous fistulas and filum terminale spinal arteriovenous malformations in 2/5 cases.	4

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
71. Boden SD, McCowin PR, Davis DO, Dina TS, Mark AS, Wiesel S. Abnormal magnetic-resonance scans of the cervical spine in asymptomatic subjects. A prospective investigation. *J Bone Joint Surg Am.* 1990;72(8):1178-1184.	Observational-Dx	100 total subjects: 63 healthy volunteers, 37 randomized symptomatic lesion of the cervical spine	To evaluate MRI finding in asymptomatic subjects.	The disc was degenerated or narrowed at 1 level or more in 25% of the subjects who were >40 years old and in almost 60% of those who were >40. The prevalence of abnormal MRI of the cervical spine as related to age in asymptomatic individuals emphasizes the dangers of predicating operative decisions on diagnostic tests without precisely matching those findings with clinical signs and symptoms.	3
72. Holtas S, Basibuyuk N, Fredriksson K. MRI in acute transverse myelopathy. *Neuroradiology.* 1993;35(3):221-226.	Review/Other-Dx	7 patients	To assess the correlation of MRI with clinical findings in transverse myelopathy.	CSF analysis showed local synthesis of immunoglobulin in the nervous system in 3 cases and signs of infectious myelitis in 1. During the acute phase 4 patients had local enlargement of the cord and all had increased signal on long TR/TE sequences. The outcome was grave in the majority of patients and there seemed to be a correlation between the degree of cord enlargement, persistence of ISI and limited recovery. Atrophy and remaining high signal intensity were noted on late MRI in patients with poor outcome. MRI correlated with clinical outcome.	4
73. Braga-Baiak A, Shah A, Pietrobon R, Braga L, Neto AC, Cook C. Intra- and inter-observer reliability of MRI examination of intervertebral disc abnormalities in patients with cervical myelopathy. *Eur J Radiol.* 2008;65(1):91-98.	Observational-Dx	10 patients	To investigate the intra- and inter-observer reliability of MRI detection of CSM in subjects who also had co-existing intervertebral disc abnormalities.	High intra-observer percent agreement but relatively low Kappa values on selected variables. Inter-observer reliability was also low and neither observation was improved with operational guidelines. We believe that those low values may be associated with the base rate problem of Kappa. In conclusion, this study demonstrated high intra-observer percent agreement in MR examination for intervertebral disc abnormalities in patients with underlying cervical myelopathy, but differing levels of intra- and inter-observer Kappa agreement among 7 radiologists.	1

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
74. Imagama S, Matsuyama Y, Sakai Y, et al. Image classification of idiopathic spinal cord herniation based on symptom severity and surgical outcome: a multicenter study. *J Neurosurg Spine.* 2009;11(3):310-319.	Review/Other-Dx	12 patients	To provide the first evidence for image classification of idiopathic spinal cord herniation in a multicenter study.	Patients with Type P herniation had a good postoperative recovery, and those with a Type C location had significant severe preoperative lower-extremity paralysis and a significantly poor postoperative recovery. Patients with a bone defect had a significantly severe preoperative myelopathy, but showed no difference in postoperative recovery. The authors' results showed that a Type C classification and a bone defect have strong relationships with severity of symptoms and surgical outcome and are important imaging and clinical features for idiopathic spinal cord herniation. These findings may allow surgeons to determine the severity of preoperative symptoms and the probable surgical outcome from imaging.	4
75. Jacob A, Weinshenker BG. An approach to the diagnosis of acute transverse myelitis. *Semin Neurol.* 2008;28(1):105-120.	Review/Other-Dx	N/A	To review the diagnostic clues and pitfalls of the not uncommon clinical scenario of a presumed myelopathy with normal MRI and the clinical, immunological, and radiological findings of noncompressive myelopathies are reviewed, as are how these findings can be used to distinguish between demyelinating, infectious, other inflammatory, vascular, neoplastic, and paraneoplastic etiologies.	The differential diagnosis of ATM is broad. Therefore, physicians must be aware of the many potential etiologies for acute myelopathy, and should pursue an ordered, efficient, and cost-effective approach to the diagnosis based on the patient's clinical history, examination, and MRI findings.	4
76. Mummaneni PV, Kaiser MG, Matz PG, et al. Preoperative patient selection with magnetic resonance imaging, computed tomography, and electroencephalography: does the test predict outcome after cervical surgery? *J Neurosurg Spine.* 2009;11(2):119-129.	Review/Other-Dx	N/A	To use evidence-based medicine to assess whether preoperative imaging or electromyography predicts surgical outcomes in patients undergoing cervical surgery.	Preoperative MRI and CT myelography are successful in confirming clinical radiculopathy (Class II). Multilevel T2 hyperintensity, T1 focal hypointensity combined with T2 focal hyperintensity and spinal cord atrophy each convey a poor prognosis (Class III). There is conflicting data concerning whether focal T2 hyperintensity or cervical stenosis are associated with a worse outcome. Electromyography has mixed utility in predicting outcome (Class III).	4
77. Northover JR, Wild JB, Braybrooke J, Blanco J. The epidemiology of cervical spondylotic myelopathy. *Skeletal Radiol.* 2012;41(12):1543-1546.	Review/Other-Dx	41 patients	To examine the epidemiology of CSM of patients presenting to our hospital.	Cervical myelopathy was found to be more common in male patients to the ratio of approximately 2.7:1, with an average age at diagnosis of 63.8 years. Multi-level disease was seen in the majority of patients, with C5/6 being the most commonly affected level.	4

Myelopathy
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
78. Oshima Y, Seichi A, Takeshita K, et al. Natural course and prognostic factors in patients with mild cervical spondylotic myelopathy with increased signal intensity on T2-weighted magnetic resonance imaging. *Spine (Phila Pa 1976).* 2012;37(22):1909-1913.	Review/Other-Dx	45 patients	To investigate natural course and prognostic factors in patients with mild forms of CSM, focusing on intramedullary ISI on T2-weighted MRI.	16 patients gradually deteriorated and underwent decompression surgery, whereas 27 patients did not. Apart from these, 2 patients with acute SCI after minor trauma underwent surgery. Kaplan-Meier survival analysis revealed that 82% or 56% of patients did not require surgery 5 or 10 years after the initial treatment, respectively. As for prognostic factors, Cox proportional hazard analysis revealed that total cervical range of motion (hazard ratio: 3.25), segmental kyphosis in the maximum compression segment (hazard ratio: 4.51), and local slip (hazard ratio: 4.67) were statistically significant.	4

Evidence Table Key

Study Quality Category Definitions

- *Category 1* The study is well-designed and accounts for common biases.
- *Category 2* The study is moderately well-designed and accounts for most common biases.
- *Category 3* There are important study design limitations.
- *Category 4* The study is not useful as primary evidence. The article may not be a clinical study or the study design is invalid, or conclusions are based on expert consensus. For example:
  a) the study does not meet the criteria for or is not a hypothesis-based clinical study (e.g., a book chapter or case report or case series description);
  b) the study may synthesize and draw conclusions about several studies such as a literature review article or book chapter but is not primary evidence;
  c) the study is an expert opinion or consensus document.
- M = Meta-analysis

Dx = Diagnostic

Tx = Treatment

Abbreviations Key

ADC = Apparent diffusion coefficient

ATM = Acute transverse myelitis

CSF = Cerebrospinal fluid

CSM = Cervical spondylotic myelopathy

CT = Computed tomography

DSA = Digital subtraction angiography

DTI = Diffusion-tensor imaging

DWI = Diffusion-weighted imaging

FA = Fractional anisotropy

FDG-PET = Fluorine-18-2-fluoro-2-deoxy-D-glucose-positron emission tomography

FISP = Fast imaging with steady-state precession

fMRI = Functional magnetic resonance imaging

Gd-DTPA = Gadolinium-diethylenetriamine pentaacetic acid

ISI = Increased signal intensity

MRA = Magnetic resonance angiography

MRI = Magnetic resonance imaging

MS = Multiple sclerosis

NPV = Negative predictive value

OR = Odds ratio

ROI = Region of interest

SCI = Spinal cord injury

SIR = Signal intensity ratio

SUV = Standardized uptake value

US = Ultrasound