*National Imaging Associates, Inc.	
Clinical guidelines **THORACIC SPINE CT**	**Original Date: September 1997**
CPT Codes: 72128, 72129, 72130	**Last Revised Date: December 2023**
Guideline Number: NIA_CG_043	**Implementation Date: July 2024**

GENERAL INFORMATION

- *It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.*
- *Where a specific clinical indication is not directly addressed in this guideline, medical necessity determination will be made based on widely accepted standard of care criteria. These criteria are supported by evidence-based or peer-reviewed sources such as medical literature, societal guidelines and state/national recommendations.*

INDICATIONS FOR THORACIC SPINE CT

[+]If there is a combination request* for an overlapping body part, either requested at the same time or sequentially (within the past 3 months) the results of the prior study should be:

- **Inconclusive or show a need for additional or follow up imaging evaluation OR**
- **The office notes should clearly document an indication why overlapping imaging is needed and how it will change management for the patient (the entire spinal cord and/or autonomic postganglionic chain must be assessed)**

(*Unless approvable in the combination section as noted in the guidelines)

For evaluation of neurologic deficits when Thoracic Spine MRI is contraindicated or inappropriate[1-3]

- With any of the following new neurological deficits documented on physical exam
  - Extremity muscular weakness (and not likely caused by plexopathy, or peripheral neuropathy)[4, 5]
  - Pathologic (e.g., Babinski, Chaddock Sign) reflexes

- Pathologic (e.g., Babinski, Lhermitte's sign, Chaddock Sign, Hoffman's and other upper motor neuron signs); **OR** abnormal deep tendon reflexes (and not likely caused by plexopathy, or peripheral neuropathy)
- Absent/decreased sensory changes along a particular thoracic dermatome (nerve distribution): pin prick, touch, vibration, proprioception, or temperature weakness (and not likely caused by plexopathy, or peripheral neuropathy)
- Upper or lower extremity increase muscle tone/spasticity and likely localized to the thoracic spinal cord
- New onset bowel or bladder dysfunction (e.g., retention or incontinence) - not related to an inherent bowel or bladder process
- Gait abnormalities (see Table 1 for more details)

- Suspected cord compression with any neurological deficits as listed above

For evaluation of back pain with any of the following when Thoracic Spine MRI is contraindicated[6-9]

- With new or worsening objective neurologic deficits on exam, as above
- Failure of conservative treatment* for a minimum of six (6) weeks within the last six (6) months;[10]

  NOTE - Failure of conservative treatment is defined as one of the following:
  - Lack of meaningful improvement after a full course of treatment; **OR**
  - Progression or worsening of symptoms during treatment; **OR**
  - Documentation of a medical reason the member is unable to participate in treatment

  Closure of medical or therapy offices, patient inconvenience, or noncompliance without explanation does not constitute "inability to complete" treatment.
- With progression or worsening of symptoms during the course of conservative treatment*
- With an abnormal electromyography (EMG) or nerve conduction study (if performed) indicating a thoracic radiculopathy. (EMG is not recommended to determine the cause of axial lumbar, thoracic, or cervical spine pain)[11]
- Isolated back pain in pediatric population[12] – conservative care not required if red flags present. Red flags that prompt imaging include any of the following:
  - Age 5 or younger, **OR**
  - Constant pain, **OR**
  - Pain lasting > 4 weeks, **OR**
  - Abnormal neurologic examination, **OR**
  - Early morning stiffness and/or gelling, **OR**
  - Night pain that prevents or disrupts sleep, **OR**
  - Radicular pain, **OR**
  - Fever or weight loss or malaise, **OR**
  - Postural changes (e.g., kyphosis or scoliosis), **OR**

- Limp (or refusal to walk in a younger child < 5yo)

As part of initial pre-operative/post-operative/procedural evaluation ("CT best examination to assess for hardware complication, extent of fusion and pseudoarthrosis"[13, 14] and MRI for cord, nerve root compression, disc pathology, or post-op infection)

If ordered by Neurosurgeon or orthopedic surgeon for purposes of surgical planning. A contraindication to MRI is not required

- For preoperative evaluation/planning
- CT discogram
- Evaluation of post operative pseudoarthrosis after initial x-rays (CT should not be done before 6 months after surgery)
- CSF leak highly suspected and supported by patient history and/or physical exam findings (leak (known or suspected spontaneous (idiopathic) intracranial hypotension (SIH), post lumbar puncture headache, post spinal surgery headache, orthostatic headache, rhinorrhea or otorrhea, or cerebrospinal-venous fistula -preferred exam CT myelogram)[15]
- Prior to spinal cord stimulator to exclude canal stenosis if no prior imaging of the thoracic spine has been done recently and MRI is contraindicated
- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery in the last 6 months. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested (routine surveillance post-op not indicated without symptoms)
- Surgical infection as evidenced by signs/symptoms, laboratory, or prior imaging findings
- New or changing neurological deficits or symptoms post-operatively [13, 16] - see neurological deficit section above
- When combo requests are submitted (i.e., MRI and CT of the spine), the office notes should clearly document the need for both studies to be done simultaneously, i.e., the need for both soft tissue and bony anatomy is required[17]
    - Combination requests where both thoracic spine CT and MRI thoracic spine are both approvable (not an all-inclusive list):
        - OPLL (Ossification of posterior longitudinal ligament)
            - Most common in cervical spine (rare but more severe in thoracic spine)[18]
        - Pathologic or complex fractures
        - Malignant process of spine with both bony and soft tissue involvement
        - Clearly documented indication for bony and soft tissue abnormality where assessment will change management for the patient

For evaluation of suspected myelopathy when Thoracic Spine MRI is contraindicated[19-23]

- Does NOT require conservative care

- Progressive symptoms including unsteadiness; broad-based gait; increased muscle tone; pins and needles sensation; weakness and wasting of the lower limbs; diminished sensation to light touch, temperature, proprioception, and vibration; limb hyperreflexia and pathologic reflexes; bowel and bladder dysfunction in more severe cases
- Any of the neurological deficits as noted above

For evaluation of trauma or acute injury[24]

- Presents with any of the following neurological deficits as above
- With progression or worsening of symptoms during the course of a trial of conservative treatment*
- History of underlying spinal abnormalities (i.e., ankylosing spondylitis, diffuse idiopathic skeletal hyperostosis) (Both MRI and CT would be approvable)[25-27]
- When the patient is clinically unevaluable or there are preliminary imaging findings (x-ray or CT) needing further evaluation

("MRI and CT provide complementary information. When indicated It is appropriate to perform both examinations")[24]

For evaluation of known fracture or known/new compression fractures with worsening back pain[24, 28]

- To assess union of a fracture when physical examination, plain radiographs, or prior imaging suggest delayed or non-healing
- To determine the position of fracture fragments
- With history of malignancy (if MRI is contraindicated or cannot be performed)
- With an associated new focal neurologic deficit as above[29]
- Prior to a planned surgery/intervention or if the results of the CT will change management

CT myelogram: When MRI cannot be performed/contraindicated/surgeon preference[30-34]

- When signs and symptoms are inconsistent or not explained by the MRI findings
- Demonstration of the site of a CSF leak (known or suspected spontaneous (idiopathic) intracranial hypotension (SIH), post lumbar puncture headache, post spinal surgery headache, orthostatic headache, rhinorrhea or otorrhea, or cerebrospinal-venous fistula)
- Surgical planning, especially regarding to the nerve roots or evaluation of dural sac

For evaluation of tumor, cancer, or metastasis with any of the following:

(MRI is usually the preferred study- CT may be needed to further characterize solitary indeterminate lesions seen on MRI)[35]

- **Primary tumor**

- Initial staging primary spinal tumor[36]
- Follow-up of known primary cancer of patient undergoing active treatment within the past year or as per surveillance imaging guidance for that cancer
- Known spinal tumor with new signs or symptoms (e.g., new or increasing nontraumatic pain, physical, laboratory, and/or imaging findings)
- With an associated new focal neurologic deficit as above[29]

- **Metastatic tumor**
  - With evidence of metastasis on bone scan needing further clarification OR inconclusive findings on a prior imaging exam
  - With an associated new focal neurologic deficit[29]
  - Known malignancy with new signs or symptoms (e.g., new or increasing nontraumatic pain, radiculopathy or neck pain that occurs at night and wakes the patient from sleep with known active cancer, physical, laboratory, and/or imaging findings) in a tumor that tends to metastasize to the spine[37, 38]

Further evaluation of indeterminate findings on prior imaging (unless follow up is otherwise specified within the guideline):

- For initial evaluation of an inconclusive finding on a prior imaging report that requires further clarification. When MRI cannot be performed, is contraindicated, or CT is preferred to characterize the finding.
- One follow-up exam of a prior indeterminate MR/CT finding to ensure no suspicious interval change has occurred. (No further surveillance unless specified as highly suspicious or change was found on last follow-up exam.) (When MRI cannot be performed, is contraindicated, or CT is preferred to characterize the finding.)

Indication for combination studies for the initial pre-therapy staging of cancer, OR active monitoring for recurrence as clinically indicated, OR evaluation of suspected metastases

- ≤ 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine, or Lumbar Spine

For evaluation of known or suspected infection (osteomyelitis), abscess or inflammatory disease when Thoracic MRI is contraindicated or cannot be performed[39, 40]

- As evidenced by signs and/or symptoms, laboratory (i.e., abnormal white blood cell count, ESR and/or CRP) or prior imaging findings[41]
- Follow-up imaging of infection
  - With worsening symptoms/laboratory values (i.e., white blood cell count, ESR/CRP) or radiographic findings[42]

Spondyloarthropathies

- Ankylosing Spondylitis/Spondyloarthropathies with non-diagnostic or indeterminate x-ray and appropriate rheumatology workup

For evaluation of spine abnormalities related to immune system suppression, e.g., HIV, chemotherapy, leukemia, or lymphoma when Thoracic MRI is contraindicated[39]

- As evidenced by signs/symptoms, laboratory, or prior imaging findings

Other Indications for a Thoracic Spine CT when MRI is contraindicated or cannot be performed

(Note- See combination requests, below, for initial advanced imaging assessment and pre-operatively)

- Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata[43-45]
- Known Arnold-Chiari syndrome (For initial imaging (one-time initial modality assessment) see combination below)
    - Known Chiari I malformation without syrinx or hydrocephalus, follow-up imaging after initial diagnosis with new or changing signs/symptoms or exam findings consistent with spinal cord pathology[46]
    - Known Chiari II (Arnold-Chiari syndrome), III, or IV malformation
- Syrinx or syringomyelia (known or suspected)
    - With neurologic findings and/or predisposing conditions (e.g., Chiari malformation, prior trauma, neoplasm, arachnoiditis, severe spondylosis)[47]
    - To further characterize a suspicious abnormality seen on prior imaging
    - Known syrinx with new/worsening symptoms
- Toe walking in a child with signs/symptoms of myelopathy localized to the Thoracic Spine
- Suspected neuroinflammatory Conditions/Diseases (e.g., sarcoidosis, Behcet's)
    - After detailed neurological exam and appropriate initial work up

COMBINATION STUDIES WITH THORACIC SPINE CT WHEN MRI IS CONTRAINDICATED OR CANNOT BE PERFORMED OR SURGEON PREFERENCE

Cervical and Thoracic CT

- Initial evaluation of known or suspected syrinx or syringomyelia
    - With neurologic findings and/or predisposing conditions (e.g., Chiari malformation, prior trauma, neoplasm, arachnoiditis, severe spondylosis[47])
    - To further characterize a suspicious abnormality seen on prior imaging
    - Known syrinx with new/worsening symptom

Any combination of Cervical and/or Thoracic and/or Lumbar CTs

Note: These body regions might be evaluated separately or in combination as documented in the clinical notes by physical examination findings (e.g., localization to a particular segment of the spinal cord), patient history, and other available information, including prior imaging.

Exception- Indications for combination studies[48, 49]: Are approved indications as noted below and being performed in children who will need anesthesia for the procedure

- Any combination of these studies for:
    - Survey/complete initial assessment of infant/child with congenital scoliosis or juvenile idiopathic scoliosis under the age of 10[50-52] (e.g., congenital scoliosis, idiopathic scoliosis, scoliosis with vertebral anomalies)
    - In the presence of neurological deficit, progressive spinal deformity, or for preoperative planning[53]
    - Back pain with known vertebral anomalies (hemivertebrae, hypoplasia, agenesis, butterfly, segmentation defect, bars, or congenital wedging) in a child on preliminary imaging
    - Scoliosis with any of the following[54]:
        - Progressive spinal deformity;
        - Neurologic deficit (new or unexplained);
        - Early onset;
        - Atypical curve (e.g., short segment, >30' kyphosis, left thoracic curve, associated organ anomalies);
        - Pre-operative planning; OR
        - When office notes clearly document how imaging will change management
- Arnold-Chiari malformations[55, 56]
    - Arnold-Chiari I
        - For evaluation of spinal abnormalities associated with initial diagnosis of Arnold-Chiari Malformation. (C/T/L spine due to association with tethered cord and syringomyelia), and initial imaging has not been completed[44, 50]
    - Arnold-Chiari II-IV - For initial evaluation and follow-up as appropriate
        - Usually associated with open and closed spinal dysraphism, particularly meningomyelocele)
- Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata,[43-45] when anesthesia required for imaging[57] (e.g., meningomyelocele, lipomeningomyelocele, diastematomyelia, fatty/thickened filum terminale, and other spinal cord malformations)
- Oncological Applications (e.g., primary nervous system, metastatic)
    - Drop metastasis from brain or spine (imaging also includes brain; CT spine imaging in this scenario is usually CT myelogram)- See Overview
    - Suspected leptomeningeal carcinomatosis (LC)[58]- See Overview

    - Any combination of these for spinal survey in patient with metastases
    - Tumor evaluation and monitoring in neurocutaneous syndromes
- CSF leak highly suspected and supported by patient history and/or physical exam findings (leak (known or suspected spontaneous (idiopathic) intracranial hypotension (SIH), post lumbar puncture headache, post spinal surgery headache, orthostatic headache, rhinorrhea or otorrhea, or cerebrospinal-venous fistula -preferred exam CT myelogram))[15]
- CT myelogram when meets above guidelines and MRI is contraindicated or for surgical planning
- Post-procedure (discogram) CT

BACKGROUND

Computed tomography is used for the evaluation, assessment of severity, and follow-up of diseases of the spine. Its use in the thoracic spine is limited, however, due to the lack of epidural fat in this part of the body. CT myelography improves the contrast severity of CT, but it is also invasive. CT may be used for conditions, e.g., degenerative changes, infection, and immune suppression, when magnetic resonance imaging (MRI) is contraindicated. It may also be used in the evaluation of tumors, cancer, or metastasis in the thoracic spine, and it may be used for preoperative and post-surgical evaluations. CT obtains images from different angles and uses computer processing to show a cross-section of body tissues and organs. CT is fast and is often performed in acute settings. It provides good visualization of cortical bone.

OVERVIEW

***Conservative Treatment**

Non-operative conservative treatment should include a multimodality approach consisting of at least one (1) active and one (1) inactive component targeting the affected region.

Active Modalities

- Physical therapy
- Physician-supervised home exercise program**
- Chiropractic care

Inactive Modalities

- Medications (e.g., NSAIDs, steroids, analgesics)
- Injections (e.g., epidural injection, selective nerve root block)
- Medical Devices (e.g., TENS unit, bracing)

****Home Exercise Program (HEP)**

The following two elements are required to meet conservative therapy guidelines for HEP:[9, 14]

- Documentation of an exercise prescription/plan provided by a physician, physical therapist, or chiropractor; **AND**

- Follow-up documentation regarding completion of HEP after the required 6-week timeframe or inability to complete HEP due to a documented medical reason (e.g., increased pain or inability to physically perform exercises).

Table 1: Gait and spine imaging[59-64]

Gait	Characteristic	Work up/Imaging
Hemiparetic	**Spastic unilateral, circumduction**	**Brain and/or, Cervical spine imaging based on associated symptoms**
Diplegic	**Spastic bilateral, circumduction**	**Brain, Cervical and Thoracic Spine imaging**
Myelopathic	**Wide based, stiff, unsteady**	**Cervical and/or Thoracic spine MRI based on associated symptoms**
Cerebellar ataxic	**Broad based, clumsy, staggering, lack of coordination, usually also with limb ataxia**	**Brain imaging see Brain MRI Guideline**
Apraxic	**Magnetic, shuffling, difficulty initiating**	**Brain imaging see Brain MRI Guideline**
Parkinsonian	**Stooped, small steps, rigid, turning en bloc, decreased arm swing**	**Brain Imaging see Brain MRI Guideline**
Choreiform	**Irregular, jerky, involuntary movements**	**Medication review, consider brain imaging as per movement disorder Brain MR guidelines**
Sensory ataxic	**Cautious, stomping, worsening without visual input (ie + Romberg)**	**EMG, blood work, consider spinal (cervical or thoracic cord imaging) imaging based on EMG**
Neurogenic	**Steppage, dragging of toes**	• **EMG initial testing;** • **BUT if there is a foot drop, lumbar spine MRI is appropriate without EMG** • **Pelvis MR if there is evidence of plexopathy**
Vestibular	**Insecure, veer to one side, worse when eyes closed, vertigo**	**Consider Brain/IAC MRI see Brain MRI Guideline**

Myelopathy – Symptom severity varies, and a high index of suspicion is essential for making the proper diagnosis in early cases. Symptoms of pain and radiculopathy may not be present. The natural history of myelopathy is characterized by neurological deterioration. The most frequently encountered symptom is gait abnormality (86%), followed by increased muscular reflexes (79.1%), pathological reflexes (65.1%), paresthesia of upper limb (69.8%), and pain (67.4%).[65]

CT Myelogram – Myelography is the instillation of intrathecal contrast media under fluoroscopy. Patients are then imaged with CT to evaluate for spinal canal pathology. Although this technique has diminished greatly due to the advent of MRI and its non-invasiveness and superior soft-tissue contrast, myelography is still a useful technique for conventional indications, such as spinal stenosis, when MRI is contraindicated, nondiagnostic or surgeon preference (see guidelines above), brachial plexus injury in neonates, radiation therapy treatment planning, and cerebrospinal fluid (CSF) leak.[66]

Back Pain with Cancer History – Bone is the third most common site of metastases after the liver and the lungs, and approximately two-thirds of all osseous metastases occur in the spine. Approximately 60–70% of patients with systemic cancer will have spinal metastasis. Radiographic (x-ray) examination should be performed in cases of back pain when a patient has a cancer history, but without known active cancer or a tumor that tends to metastasize to the spine. This can make a diagnosis in many cases. This may occasionally allow for selection of bone scan in lieu of MRI in some cases. When radiographs do not answer the clinical question, then MRI may be appropriate after a consideration of conservative care.

"Neoplasms causing VCF (vertebral compression fractures) include1) primary bone neoplasms, such as hemangioma (aggressive type) or giant cell tumors, and tumor-like conditions causing bony and cellular remodeling, such as aneurysmal bone cysts, or Paget's disease (osteitis deformans); ; 2) primary malignant neoplasms including but not limited to multiple myeloma and lymphoma; and 3) metastatic neoplasms, including and not limited to, multiple myeloma and lymphoma, and metastatic neoplasms."[28]

Most common spine metastasis involving primary metastasis originate from the following tumors in descending order: breast (21%), lung (19%), prostate (7.5%), renal (5%), gastrointestinal (4.5%), and thyroid (2.5%). While all tumors can seed to the spine, the cancers mentioned above metastasize to the spinal column early in the disease process.[37]
Drop Metastases[67] – Drop metastases are intradural extramedullary spinal metastases that arise from intracranial lesions. Common examples of intracranial neoplasms that result in drop metastases include pineal tumors, ependymomas, medulloblastomas, germinomas, primitive neuroectodermal tumors (PNET), glioblastomas multiform, anaplastic astrocytomas, oligodendrogliomas and less commonly choroid plexus neoplasms and teratomas.

Leptomeningeal Carcinomatosis[68] – Leptomeningeal carcinomatosis is a complication of cancer in which cancerous cells spread to the membranes (meninges) that covers the brain and spinal cord. The most common solid tumors that involve the leptomeninges are breast, lung, melanoma, gastrointestinal, and primary central nervous system tumors.

Table 2: CT and Cutaneous Stigmata[69]

Risk Stratification for Various Cutaneous Markers		
High Risk	Intermediate Risk	Low Risk
• Hypertrichosis • Infantile hemangioma • Atretic meningocele • DST • Subcutaneous lipoma • Caudal appendage • Segmental hemangiomas in association with LUMBAR[‡] syndrome	• Capillary malformations (also referred to as NFS or salmon patch when pink and poorly defined or PWS when darker red and well-defined)	• Coccygeal dimple • Light hair • Isolated café au lait spots • Mongolian spots • Hypo- and hypermelanotic macules or papules • Deviated or forked gluteal cleft • Nonmidline lesions
[‡]LUMBAR, lower body hemangioma and other cutaneous defects, urogenital abnormalities, ulcerations, myelopathy, bony defects, anorectal malformations, arterial anomalies, and renal anomalies.		

POLICY HISTORY

Date	Summary
Dec 2023	Conservative treatment language updated in body and background
May 2023	• Updated references • Updated background section • Clarified pathological reflexes • Added pseudoarthrosis to surgery section • Added "Further evaluation of indeterminate or questionable findings on prior imaging": • Clarified cerebellar ataxia in gait table • Removed radicular pain and malaise from Isolated Back Pain in the Pediatric population: Red flags. • Removed Additional Resources • General Information moved to beginning of guideline with added statement on clinical indications not addressed in this guideline • Added statement regarding further evaluation of indeterminate findings on prior imaging
March 2022	Added • Combination request for overlapping body part statement • Clarified muscle weakness not related to plexopathy or peripheral neuropathy • Clarified bowel and bladder dysfunction – not related to an inherent bowel or bladder problem • Descriptions for tethered cord • Clarified CT myelogram section • Background section of Drop Metastases • Background section of Leptomeningeal Carcinomatosis • Clarified toe walking in pediatric patient with myelopathy for thoracic spine Removed • Removed from combination section syrinx and syringomyelia and added subsection for cervical and thoracic spine section • Removed pediatric back pain from the total spine combination section

REFERENCES

1. Evidence-Based Clinical Guidelines for Multidisciplinary Spine Care: Diagnosis and Treatment of Cervical Radiculopathy from Degenerative Disorders. North American Spine Society (NASS). Updated 2010. Accessed December 1, 2022. https://www.spine.org/Portals/0/Assets/Downloads/ResearchClinicalCare/Guidelines/CervicalRadiculopathy.pdf
2. Acharya AB, Fowler JB. Chaddock Reflex. StatPearls Publishing. Updated June 27, 2022. Accessed December 1, 2022. https://www.ncbi.nlm.nih.gov/books/NBK519555/
3. Albert TJ, Murrell SE. Surgical management of cervical radiculopathy. *J Am Acad Orthop Surg*. Nov-Dec 1999;7(6):368-76. doi:10.5435/00124635-199911000-00003
4. Moore KR, Tsuruda JS, Dailey AT. The value of MR neurography for evaluating extraspinal neuropathic leg pain: a pictorial essay. *AJNR Am J Neuroradiol*. Apr 2001;22(4):786-94.
5. Dydyk AM, Hameed S. Lumbosacral Plexopathy. StatPearls Publishing Copyright © 2022, StatPearls Publishing LLC. Updated March 26, 2022. Accessed November 16, 2022. https://www.ncbi.nlm.nih.gov/books/NBK556030/
6. Allegri M, Montella S, Salici F, et al. Mechanisms of low back pain: a guide for diagnosis and therapy. *F1000Res*. 2016;5doi:10.12688/f1000research.8105.2
7. American Association of Neurological Surgeons, Congress of Neurological Surgeons. Five things physicians and patients should question: Don't obtain imaging (plain radiographs, magnetic resonance imaging, computed tomography [CT], or other advanced imaging) of the spine in patients with non-specific acute low back pain and without red flags. Choosing Wisely Initiative ABIM Foundation. Updated 2014. Accessed November 19, 2022. https://www.choosingwisely.org/clinician-lists/american-association-neurological-surgeons-imaging-for-nonspecific-acute-low-back-pain/
8. Jarvik JG, Gold LS, Comstock BA, et al. Association of early imaging for back pain with clinical outcomes in older adults. *Jama*. Mar 17 2015;313(11):1143-53. doi:10.1001/jama.2015.1871
9. Last AR, Hulbert K. Chronic low back pain: evaluation and management. *Am Fam Physician*. Jun 15 2009;79(12):1067-74.
10. Eubanks JD. Cervical radiculopathy: nonoperative management of neck pain and radicular symptoms. *Am Fam Physician*. Jan 1 2010;81(1):33-40.
11. North American Spine Society. Five things physicians and patients should question: Don't use electromyography (EMG) and nerve conduction studies (NCS) to determine the cause of axial lumbar, thoracic or cervical spine pain. Choosing Wisely Initiative ABIM Foundation. Updated 2019. Accessed December 1, 2022. https://www.choosingwisely.org/clinician-lists/nass-emg-nerve-conduction-studies-to-determine-cause-of-spine-pain/
12. American College of Radiology. ACR Appropriateness Criteria®Back Pain–Child. American College of Radiology (ACR). Updated 2016. Accessed December 1, 2022. https://acsearch.acr.org/docs/3099011/Narrative/
13. Rao D, Scuderi G, Scuderi C, Grewal R, Sandhu SJ. The Use of Imaging in Management of Patients with Low Back Pain. *J Clin Imaging Sci*. 2018;8:30. doi:10.4103/jcis.JCIS_16_18

14. American College of Radiology. ACR Appropriateness Criteria® Low Back Pain. American College of Radiology (ACR). Updated 2021. Accessed January 29, 2023. https://acsearch.acr.org/docs/69483/Narrative/
15. Starling A, Hernandez F, Hoxworth JM, et al. Sensitivity of MRI of the spine compared with CT myelography in orthostatic headache with CSF leak. *Neurology*. Nov 12 2013;81(20):1789-92. doi:10.1212/01.wnl.0000435555.13695.22
16. Corona-Cedillo R, Saavedra-Navarrete MT, Espinoza-Garcia JJ, Mendoza-Aguilar AN, Ternovoy SK, Roldan-Valadez E. Imaging Assessment of the Postoperative Spine: An Updated Pictorial Review of Selected Complications. *Biomed Res Int*. 2021;2021:9940001. doi:10.1155/2021/9940001
17. Fisher BM, Cowles S, Matulich JR, Evanson BG, Vega D, Dissanaike S. Is magnetic resonance imaging in addition to a computed tomographic scan necessary to identify clinically significant cervical spine injuries in obtunded blunt trauma patients? *Am J Surg*. Dec 2013;206(6):987-93; discussion 993-4. doi:10.1016/j.amjsurg.2013.08.021
18. Choi BW, Song KJ, Chang H. Ossification of the posterior longitudinal ligament: a review of literature. *Asian Spine J*. Dec 2011;5(4):267-76. doi:10.4184/asj.2011.5.4.267
19. American College of Radiology. ACR Appropriateness Criteria® Myelopathy. American College of Radiology (ACR). Updated 2020. Accessed January 29, 2023. https://acsearch.acr.org/docs/69484/Narrative/
20. Behrbalk E, Salame K, Regev GJ, Keynan O, Boszczyk B, Lidar Z. Delayed diagnosis of cervical spondylotic myelopathy by primary care physicians. *Neurosurg Focus*. Jul 2013;35(1):E1. doi:10.3171/2013.3.Focus1374
21. Davies BM, Mowforth OD, Smith EK, Kotter MR. Degenerative cervical myelopathy. *Bmj*. Feb 22 2018;360:k186. doi:10.1136/bmj.k186
22. de Oliveira Vilaça C, Orsini M, Leite MA, et al. Cervical Spondylotic Myelopathy: What the Neurologist Should Know. *Neurol Int*. Nov 2 2016;8(4):6330. doi:10.4081/ni.2016.6330
23. Waly FJ, Abduljabbar FH, Fortin M, Nooh A, Weber M. Preoperative Computed Tomography Myelography Parameters as Predictors of Outcome in Patients With Degenerative Cervical Myelopathy: Results of a Systematic Review. *Global Spine J*. Sep 2017;7(6):521-528. doi:10.1177/2192568217701101
24. American College of Radiology. ACR Appropriateness Criteria® Suspected Spine Trauma American College of Radiology. Updated 2018. Accessed December 1, 2022. https://acsearch.acr.org/docs/69359/Narrative/
25. American College of Radiology. ACR Appropriateness Criteria® Inflammatory Back Pain: Known or Suspected Axial Spondyloarthritis. American College of Radiology (ACR). Updated 2021. Accessed December 1, 2022. https://acsearch.acr.org/docs/3094107/Narrative/
26. Koivikko MP, Koskinen SK. MRI of cervical spine injuries complicating ankylosing spondylitis. *Skeletal Radiol*. Sep 2008;37(9):813-9. doi:10.1007/s00256-008-0484-x
27. Taljanovic MS, Hunter TB, Wisneski RJ, et al. Imaging characteristics of diffuse idiopathic skeletal hyperostosis with an emphasis on acute spinal fractures: review. *AJR Am J Roentgenol*. Sep 2009;193(3 Suppl):S10-9, Quiz S20-4. doi:10.2214/ajr.07.7102

28. American College of Radiology. ACR Appropriateness Criteria® Management of Vertebral Compression Fractures. American College of Radiology. Updated 2022. Accessed December 1, 2022. https://acsearch.acr.org/docs/70545/Narrative/
29. Alexandru D, So W. Evaluation and management of vertebral compression fractures. *Perm J*. Fall 2012;16(4):46-51. doi:10.7812/tpp/12-037
30. Grams AE, Gempt J, Förschler A. Comparison of spinal anatomy between 3-Tesla MRI and CT-myelography under healthy and pathological conditions. *Surg Radiol Anat*. Jul 2010;32(6):581-5. doi:10.1007/s00276-009-0601-0
31. Morita M, Miyauchi A, Okuda S, Oda T, Iwasaki M. Comparison between MRI and myelography in lumbar spinal canal stenosis for the decision of levels of decompression surgery. *J Spinal Disord Tech*. Feb 2011;24(1):31-6. doi:10.1097/BSD.0b013e3181d4c993
32. Naganawa T, Miyamoto K, Ogura H, Suzuki N, Shimizu K. Comparison of magnetic resonance imaging and computed tomogram-myelography for evaluation of cross sections of cervical spinal morphology. *Spine (Phila Pa 1976)*. Jan 1 2011;36(1):50-6. doi:10.1097/BRS.0b013e3181cb469c
33. Evidence-Based Clinical Guidelines for Multidisciplinary Spine Care: Diagnosis and Treatment of Lumbar Disc Herniation with Radiculopathy. North American Spine Society (NASS). Updated 2012. Accessed December 1, 2022. https://www.spine.org/Portals/0/Assets/Downloads/ResearchClinicalCare/Guidelines/LumbarDiscHerniation.pdf
34. Ozdoba C, Gralla J, Rieke A, Binggeli R, Schroth G. Myelography in the Age of MRI: Why We Do It, and How We Do It. *Radiol Res Pract*. 2011;2011:329017. doi:10.1155/2011/329017
35. Kim YS, Han IH, Lee IS, Lee JS, Choi BK. Imaging findings of solitary spinal bony lesions and the differential diagnosis of benign and malignant lesions. *J Korean Neurosurg Soc*. 2012;52(2):126-132. doi:10.3340/jkns.2012.52.2.126
36. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines): Central Nervous System Cancers Version 2.2022. National Comprehensive Cancer Network (NCCN). Updated September 29, 2022. Accessed January 23, 2023. https://www.nccn.org/professionals/physician_gls/pdf/cns.pdf
37. Ziu E, Viswanathan VK, Mesfin FB. Spinal Metastasis. StatPearls Publishing. Updated August 22, 2022. Accessed December 1, 2022. https://www.ncbi.nlm.nih.gov/books/NBK441950/
38. McDonald MA, Kirsch CFE, Amin BY, et al. ACR Appropriateness Criteria(®) Cervical Neck Pain or Cervical Radiculopathy. *J Am Coll Radiol*. May 2019;16(5s):S57-s76. doi:10.1016/j.jacr.2019.02.023
39. American College of Radiology. ACR Appropriateness Criteria® Suspected Spine Infection. American College of Radiology (ACR). Updated 2021. Accessed December 1, 2022. https://acsearch.acr.org/docs/3148734/Narrative/
40. Lener S, Hartmann S, Barbagallo GMV, Certo F, Thomé C, Tschugg A. Management of spinal infection: a review of the literature. *Acta Neurochir (Wien)*. Mar 2018;160(3):487-496. doi:10.1007/s00701-018-3467-2
41. Bond A, Manian FA. Spinal Epidural Abscess: A Review with Special Emphasis on Earlier Diagnosis. *Biomed Res Int*. 2016;2016:1614328. doi:10.1155/2016/1614328

42. Berbari EF, Kanj SS, Kowalski TJ, et al. 2015 Infectious Diseases Society of America (IDSA) Clinical Practice Guidelines for the Diagnosis and Treatment of Native Vertebral Osteomyelitis in Adults. *Clin Infect Dis*. Sep 15 2015;61(6):e26-46. doi:10.1093/cid/civ482
43. Düz B, Gocmen S, Secer HI, Basal S, Gönül E. Tethered cord syndrome in adulthood. *J Spinal Cord Med*. 2008;31(3):272-8. doi:10.1080/10790268.2008.11760722
44. Milhorat TH, Bolognese PA, Nishikawa M, et al. Association of Chiari malformation type I and tethered cord syndrome: preliminary results of sectioning filum terminale. *Surg Neurol*. Jul 2009;72(1):20-35. doi:10.1016/j.surneu.2009.03.008
45. Zalatimo O. Tethered Spinal Cord Syndrome. American Association of Neurological Surgeons (AANS). Accessed December 1, 2022. https://www.aans.org/Patients/Neurosurgical-Conditions-and-Treatments/Tethered-Spinal-Cord-Syndrome
46. Whitson WJ, Lane JR, Bauer DF, Durham SR. A prospective natural history study of nonoperatively managed Chiari I malformation: does follow-up MRI surveillance alter surgical decision making? *J Neurosurg Pediatr*. Aug 2015;16(2):159-66. doi:10.3171/2014.12.Peds14301
47. Timpone VM, Patel SH. MRI of a syrinx: is contrast material always necessary? *AJR Am J Roentgenol*. May 2015;204(5):1082-5. doi:10.2214/ajr.14.13310
48. American College of Radiology. ACR Appropriateness Criteria® Headache. American College of Radiology. Updated 2022. Accessed January 23, 2023. https://acsearch.acr.org/docs/69482/Narrative/
49. American College of Radiology. ACR Appropriateness Criteria® Headache-Child. American College of Radiology. Updated 2017. Accessed December 1, 2022. https://acsearch.acr.org/docs/69439/Narrative/
50. Strahle J, Smith BW, Martinez M, et al. The association between Chiari malformation Type I, spinal syrinx, and scoliosis. *J Neurosurg Pediatr*. Jun 2015;15(6):607-11. doi:10.3171/2014.11.Peds14135
51. Juvenile Scoliosis. Scoliosis Research Society (SRS). Accessed December 1, 2022. https://www.srs.org/professionals/online-education-and-resources/conditions-and-treatments/juvenile-scoliosis
52. American College of Radiology. ACR Appropriateness Criteria® Scoliosis-Child. American College of Radiology. Updated 2018. Accessed December 1, 2022. https://acsearch.acr.org/docs/3101564/Narrative/
53. Trenga AP, Singla A, Feger MA, Abel MF. Patterns of congenital bony spinal deformity and associated neural anomalies on X-ray and magnetic resonance imaging. *J Child Orthop*. Aug 2016;10(4):343-52. doi:10.1007/s11832-016-0752-6
54. Ozturk C, Karadereler S, Ornek I, Enercan M, Ganiyusufoglu K, Hamzaoglu A. The role of routine magnetic resonance imaging in the preoperative evaluation of adolescent idiopathic scoliosis. *Int Orthop*. Apr 2010;34(4):543-6. doi:10.1007/s00264-009-0817-y
55. Strahle J, Muraszko KM, Kapurch J, Bapuraj JR, Garton HJ, Maher CO. Chiari malformation Type I and syrinx in children undergoing magnetic resonance imaging. *J Neurosurg Pediatr*. Aug 2011;8(2):205-13. doi:10.3171/2011.5.Peds1121
56. Radic JAE, Cochrane DD. Choosing Wisely Canada: Pediatric Neurosurgery Recommendations. *Paediatr Child Health*. Sep 2018;23(6):383-387. doi:10.1093/pch/pxy012

57. Hertzler DA, 2nd, DePowell JJ, Stevenson CB, Mangano FT. Tethered cord syndrome: a review of the literature from embryology to adult presentation. *Neurosurg Focus*. Jul 2010;29(1):E1. doi:10.3171/2010.3.Focus1079
58. Shah LM, Salzman KL. Imaging of spinal metastatic disease. *Int J Surg Oncol*. 2011;2011:769753. doi:10.1155/2011/769753
59. Chhetri SK, Gow D, Shaunak S, Varma A. Clinical assessment of the sensory ataxias; diagnostic algorithm with illustrative cases. *Pract Neurol*. Aug 2014;14(4):242-51. doi:10.1136/practneurol-2013-000764
60. Foster H, Drummond P, Jandial S, Clinch J, Wood M, Driscoll S. Evaluation of gait disorders in children. BMJ Best Practice. Updated February 23, 2021. Accessed January 23, 2023. https://bestpractice.bmj.com/topics/en-us/709
61. Standford Medicine. Gait Abnormalities. Stanford University. Accessed January 23, 2023. https://stanfordmedicine25.stanford.edu/the25/gait.html
62. Haynes KB, Wimberly RL, VanPelt JM, Jo CH, Riccio AI, Delgado MR. Toe Walking: A Neurological Perspective After Referral From Pediatric Orthopaedic Surgeons. *J Pediatr Orthop*. Mar 2018;38(3):152-156. doi:10.1097/bpo.0000000000001115
63. Marshall FJ. Approach to the elderly patient with gait disturbance. *Neurol Clin Pract*. Jun 2012;2(2):103-111. doi:10.1212/CPJ.0b013e31825a7823
64. Pirker W, Katzenschlager R. Gait disorders in adults and the elderly : A clinical guide. *Wien Klin Wochenschr*. Feb 2017;129(3-4):81-95. doi:10.1007/s00508-016-1096-4
65. Vitzthum HE, Dalitz K. Analysis of five specific scores for cervical spondylogenic myelopathy. *Eur Spine J*. Dec 2007;16(12):2096-103. doi:10.1007/s00586-007-0512-x
66. Pomerantz SR. Myelography: modern technique and indications. *Handb Clin Neurol*. 2016;135:193-208. doi:10.1016/b978-0-444-53485-9.00010-6
67. Ahmed A. MRI features of disseminated 'drop metastases'. *S Afr Med J*. Jul 2008;98(7):522-3.
68. Batool A, Kasi A. Leptomeningeal Carcinomatosis. StatPearls Publishing Copyright © 2022, StatPearls Publishing LLC. Updated April 5, 2022. Accessed December 1, 2022. https://www.ncbi.nlm.nih.gov/books/NBK499862/
69. Dias M, Partington M. Congenital Brain and Spinal Cord Malformations and Their Associated Cutaneous Markers. *Pediatrics*. Oct 2015;136(4):e1105-19. doi:10.1542/peds.2015-2854

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