National Imaging Associates, Inc.*	
Clinical guidelines **THORACIC SPINE CT**	**Original Date: September 1997**
CPT Codes: 72128, 72129, 72130	**Last Revised Date: April 2021**
Guideline Number: NIA_CG_043	**Implementation Date: January 2022**

INDICATIONS FOR THORACIC SPINE CT
(Combination requests at end of the document)

For evaluation of neurologic deficits when Thoracic Spine MRI is contraindicated or inappropriate (Acharya, 2019; ACR, 2013; NASS, 2010~~; Acharya, 2019~~)

- **With any of the following new neurological deficits documented on physical exam**
  - **Extremity muscular weakness**
  - **Pathologic (e.g., Babinski, Lhermitte's sign, Chaddock Sign,) ~~Heffman's~~ or abnormal reflexes (Teoli, 2021)**
  - **Absent/decreased sensory changes along a particular thoracic dermatome (nerve distribution): pin prick, touch, vibration, proprioception, or temperature**
  - **Upper or lower extremity increase muscle tone/spasticity**
  - **New onset bowel or bladder dysfunction (e.g., retention or incontinence)**
  - **Gait abnormalities (see ~~table below~~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
(AANSCNS, 2014; Allegri, 2016; Jarvik, 2015; Last, 2009)

- With new or worsening objective **neurologic deficits *~~.~~** on exam**, as above**
- Failure of conservative treatment* for at least six (6) weeks within the last six (6) months (ACR, 2013; Eubanks, 2010)~~.~~
- ~~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 (NASS, 2013)).~~
-

* National Imaging Associates, Inc. (NIA) is a subsidiary of Magellan Healthcare, Inc.

- Isolated back pain in pediatric population (ACR, 2016) – conservative care not required if red flags present (see combination request below cervical and lumbar spine may also be indicated)
    - Red flags that prompt imaging should include the presence of: age 5 or younger, constant pain, pain lasting >4 weeks, abnormal neurologic examination, early morning stiffness and/or gelling; night pain that prevents or disrupts sleep; radicular pain; fever; weight loss; malaise; postural changes (e.g., kyphosis or scoliosis); and limp (or refusal to walk in a younger child <5yo) AND initial radiographs have been performed (Bernstein, 2007; Feldman, 2006).
- Back pain associated with suspected inflammation, infection, or malignancy

As part of initial post-operative/procedural evaluation ("CT best examination to assess for hardware complication, extent of fusion" (ACR, 2015; Rao, 2018) 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
- 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) (Starling, 2013)
- 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)
- Changing neurologic status post-operatively.
- Surgical infection as evidenced by signs/symptoms, laboratory, or prior imaging findings.
- Residual or new neurological deficits or symptoms (Rao, 2018)- 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 (Fisher, 2013).
    - 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) (Choi, 2011)
        - 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 (ACR, 2015; Behrbalk, 2013; Davies, 2018; Vilaca, 2016; Waly, 2017)

- Does NOT require conservative care
- Progressive symptoms including hand clumsiness, worsening handwriting, difficulty with grasping and holding objects, diffuse numbness in the hands, pins and needles sensation, increasing difficulty with balance and ambulation
- Any of the neurological deficits* as noted above.

For evaluation of trauma or acute injury
(ACR, 2018)

- Presents with any of the following neurological deficits* as above
- ~~Presents with any of the following neurological deficits: muscle weakness, abnormal reflexes, and/or sensory changes along a particular dermatome (nerve distribution).~~
- With progression or worsening of symptoms during the course of conservative treatment*.
- History of underlying spinal abnormalities (i.e., ankylosing spondylitis, diffuse idiopathic skeletal hyperostosis), both MRI and CT are approvable. (ACR, 2021; Koivikko, 2008; Taljanovic, 2009) ~~(Taljanovic ,Koivikko, 2008, ACR)~~
- When the patient is clinically unevaluable or there are preliminary imaging findings (xX-ray or CT) needing further evaluation.

("MRI and CT provide complementary information. When indicated It is appropriate to perform both examinations") (ACR, 2018). ~~History of underlying spinal abnormalities (i.e., ankylosing spondylitis or Diffuse idiopathic skeletal hyperostosis (DISH) (ACR, 2018; Koivikko, 2008)~~

For evaluation of known fracture or known/new compression fractures (ACR, 2018)

- 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 (Alexandru, 2012)
- Prior to a planned surgery/intervention or if the results of the CT will change management.

~~**For evaluation of known fracture**~~

- ~~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.~~

~~**For evaluation of neurologic deficits when Thoracic Spine MRI is contraindicated or inappropriate**~~

- ~~With any of the following new neurological deficits: extremity muscular weakness; pathologic (e.g., Babinski, Hoffman's) or abnormal reflexes; or abnormal sensory changes along a particular dermatome (nerve distribution) as documented on physical exam; bowel or bladder dysfunction; spasticity, sensory, or motor level.~~

CT myelogram is indicated when signs and symptoms are incongruent with MRI findings or MRI cannot be performed/contraindicated/surgeon preference
(Grams, 2010; Morita, 2011; Naganawa, 2011; NASS, 2012; Ozdoba; 2011)

- **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 suspected myelopathy when Thoracic Spine MRI is contraindicated**~~
~~(ACR, 2015; Ando, 2019; Behrbalk, 2013; Hou, 2016)~~
- ~~Does not require conservative care~~
- ~~Concurrent cervical/thoracic imaging not recommended~~
- ~~Progressive symptoms including hand clumsiness, worsening handwriting, difficulty with~~
- ~~With any of the following new neurological deficits: extremity muscular weakness; pathologic (e.g. Babinski, Hoffman's) or abnormal reflexes; or abnormal sensory changes along a particular dermatome (nerve distribution) as documented on physical exam; bowel or bladder dysfunction; spasticity, sensory, or motor level.~~
-

~~**Ossification Posterior Longitudinal Ligament (OPPL)**~~
~~(Choi, 2011)~~

- ~~Most common in cervical spine (rare but more severe in thoracic spine)~~
- ~~CT to evaluate the calcification and MR for evaluation of cord.~~
    - ~~Both CT and MRI would be approvable if surgery is planned as signal changes in the cord would suggest a poorer prognosis after surgery~~

~~**For evaluation of known or new compression fractures with worsening back pain**~~
~~(ACR, 2018)~~

- ~~With history of malignancy (if MRI is contraindicated)~~
- ~~With an associated new focal neurologic deficit~~
- ~~Prior to a planned surgery/intervention or if the results of the CT will change management.~~

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)
(Kim, 2012)

Primary tumor

- **Initial staging or re-staging of a known primary spinal tumor.**
- **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 (Alexandru, 2012)**

Metastatic tumor:

- **With evidence of metastasis on bone scan needing further clarification OR inconclusive findings on a prior imaging exam**
- **Known malignancy with new signs or symptoms (e.g., new or increasing nontraumatic pain, physical, laboratory, and/or imaging findings) in a tumor that tends to metastasize to the spine**
- **With an associated new focal neurologic deficit (Alexandru, 2012)**
- **Initial imaging of new or increasing non-traumatic neck pain or radiculopathy or neck ~~that~~ pain that occurs at night and wakes the patient from sleep with known active cancer and a tumor that tends to metastasize to the spine (ACR, 2018; Ziu, 2019).**

For evaluation of inconclusive/indeterminate finding on prior imaging that requires further clarification:

- **One follow-up exam to ensure no suspicious change has occurred in prior imaging finding. No further surveillance unless specified as highly suspicious or change was found on last follow-up exam. When MRI cannot be performed or is contraindicated or CT is preferred to characterize the finding (ACR, 2018)**~~For evaluation of known tumor, cancer, or evidence of metastasis with any of the following (MRI is usually the preferred study, but CT may help characterize solitary indeterminate bone lesions) (Kim, 2012)~~

- ~~For staging of known tumor.~~
- ~~For follow-up evaluation of patient undergoing active cancer treatment.~~
- ~~Presents with new signs or symptoms (e.g., physical, laboratory, and/or imaging findings) of new tumor or change in tumor.~~
- ~~With evidence of metastasis on bone scan or previous imaging study.~~
- ~~New or increasing non-traumatic thoracic back pain or radiculopathy or back that pain occurs at night, and wakes the patient from sleep with known active cancer and a tumor that tends to metastasize to the spine and MRI is contraindicated (ACR, 2018; Ziu, 2019).~~

~~**For evaluation of suspected tumor when Thoracic Spine MRI is contraindicated or inappropriate**~~
~~(ACR, 2018)~~

- ~~Prior abnormal or indeterminate imaging that requires further clarification.~~

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/, abscess, or inflammatory disease when Thoracic MRI is contraindicated
(ACR, 2018; Lerner, 2018)

- Infection:
- As evidenced by signs and/or symptoms, laboratory (i.e., abnormal white blood cell count, ESR and/or CRP) or prior imaging findings (Bond, 2016)
- Follow-up imaging of infection
    - With worsening symptoms/laboratory values (i.e., white blood cell count, ESR/CRP) or radiographic findings (Berbari, 2015)

For evaluation of known or suspected inflammatory disease when MRI is contraindicated or cannot be performed:
(ACR, 2021)

- For known or suspected Ankylosing Spondylitis/Spondyloarthropathies with non-diagnostic or indeterminate x-ray and rheumatology workup**For known or suspected 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
(ACR, 2018)

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

As part of initial post-operative / procedural evaluation ("CT best examination to assess for hardware complication, extent of fusion" (ACR, 2015; Rao, 2018) **and MRI for cord, nerve root compression, disc pathology, or post-op infection)**

- 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.
- Changing neurologic status post-operatively.
- Surgical infection as evidenced by signs/symptoms, laboratory, or prior imaging findings.
- Residual or recurrent symptoms with any of the following neurological deficits: Lower extremity weakness, objective sensory loss, or abnormal reflexes (Rao, 2018).

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 (AANS, 2019; Duz, 2008; Milhorat, 2009).**
- **Known Arnold-Chiari syndrome (For initial imaging 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 (Hitson, 2015)**
    - **Known Chiari II (Arnold-Chiari syndrome), III, or IV malformation**
    - ~~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 (Timpone, 2015)),**
    - **To further characterize a suspicious abnormality seen on prior imaging.**
    - **Known syrinx with new/worsening symptoms.**
- **Toe walking in a child when associated with upper motor neuron signs, including hyperreflexia, spasticity; or orthopedic deformity with concern for spinal cord pathology (e.g., pes cavus, clawed toes, leg or foot length deformity (excluding tight heel cords))**
- ~~**Other Indications for a Thoracic Spine CT**~~

~~For preoperative evaluation and Thoracic MRI is contraindicated~~
~~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.~~
~~CT discogram.~~
~~Suspected cord compression with any of the following neurologic deficits, e.g., extremity weakness, sensory deficits, abnormal gait; abnormal reflexes; spinal level; bowel or bladder incontinence and Thoracic Spine MRI is contraindicated.~~
~~Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata (AANS; Duz, 2008; Milhorat, 2009; NIH) when Thoracic Spine MRI is contraindicated~~
~~Ankylosing Spondylitis/Spondyloarthropathies with non-diagnostic or indeterminate x-ray and rheumatology workup (Akgul, 2011; Bennett, 2010; Ostergaard, 2012; Seiper, 2009)~~
~~Known Arnold-Chiari syndrome and Thoracic MRI is contraindicated (Milhorat, 2009; Strahle, 2015).~~
~~Congenital abnormalities when Thoracic Spine MRI is contraindicated or for characterization of bony detail (Trenga, 2016):~~
~~In the presence of neurologic deficit, progressive spinal deformity, or for preoperative planning (Trenga, 2016)~~
~~Back pain and vertebral anomalies (hemivertebrae, hypoplasia, agenesis, butterfly, segmentation defect, bars, or congenital wedging) in a child on preliminary imaging.~~
~~Scoliosis with any of the following:~~
~~Progressive spinal deformity;~~
~~Neurologic deficit;~~
~~Early onset;~~

~~Atypical curve (e.g., short segment, >30 degee kyphosis, left thoracic curve, associated organ anomalies);~~
~~Pre-operative planning; OR~~
~~When office notes clearly document how imaging will change management.~~
~~Syrinx or syringomyelia (known or suspected):and Thoracic Spine MRI is contraindicated:~~
~~With neurologic findings and/or predisposing conditions (e.g., Chiari malformation, prior trauma, neoplasm, arachnoiditis, severe spondylosis (Timpone, 2015)),~~
~~To further characterize a suspicious abnormality seen on prior imaging.~~
~~Known syrinx with worsening symptoms.~~
~~CSF leak highly suspected and supported by patient history and/or physical exam findings (CT myelogram).~~
~~For pediatric population (ACR, 2016)~~
~~Red flags that prompt imaging should include the presence of constant pain, night pain, and radicular pain lasting for 4 weeks or more and initial radiographs preformed (ACR, 2016).~~
~~Back pain associated with suspected inflammation, infection, or malignancy~~

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

Indications for combination studies: (ACR, 2017, 2019) - For approved indications as noted below and being performed in a child under 8 years of age who will need anesthesia for the procedure

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

- **Any combination of these studies for:**
  - **Scoliosis survey in infant/child with congenital scoliosis or juvenile idiopathic scoliosis under the age of 10 (ACR, 2018; SRS, 2019; Strahle, 2015)~~.~~**
  - **In the presence of neurological deficit, progressive spinal deformity, or for preoperative planning (Trenga, 2016)**
  - **Back pain and vertebral anomalies (hemivertebrae, hypoplasia, agenesis, butterfly, segmentation defect, bars, or congenital wedging) in a child on preliminary imaging~~.~~**
  - **Scoliosis with any of the following (Ozturk, 2010):**
    - **Progressive spinal deformity;**
    - **Neurologic deficit;**
    - **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 I (Radic, 2018; Strahle, 2011)**

    - 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 (Milhorat, 2009; Strahle, 2015).
  - Arnold-Chiari II-IV
    - For initial evaluation and follow-up as appropriate
- Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or high-risk cutaneous stigmata (AANS, 2019; Duz, 2008; Milhorat, 2009), when anesthesia required for imaging (Hertzler, 2010).
- Toe walking in a child when associated with upper motor neuron signs including hyperreflexia, spasticity; or orthopedic deformity with concern for spinal cord pathology (e.g., pes cavus, clawed toes, leg or foot length deformity (excluding tight heel cords))
- Back pain in a child with any of the following red flags (conservative care not required when red flags present):
    - Red flags that prompt imaging should include the presence of: age 5 or younger, constant pain, pain lasting >4 weeks, abnormal neurologic examination, early morning stiffness and/or gelling; night pain that prevents or disrupts sleep; radicular pain; fever; weight loss; malaise; postural changes (e.g., kyphosis or scoliosis); and limp (or refusal to walk in a younger child <5yo), AND initial radiographs have been performed (Bernstein, 2007; Feldman, 2006)
- Drop metastasis from brain or spine (imaging also includes brain; CT spine imaging in this scenario is usually CT myelogram).
  - Suspected leptomeningeal carcinomatosis (LC) (Shah, 2011)
  - Any combination of these for spinal survey in patient with metastases.
  - Tumor evaluation and monitoring in neurocutaneous syndromes - See Background
  - 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) (Starling, 2013)
  - CT myelogram when meets above guidelines and MRI is contraindicated or for surgical planning
  - Post-procedure (discogram) CT

~~**Cervical/Thoracic/Lumbar CTs:**~~

- ~~CT myelogram or discogram.~~
- ~~Any combination of these for scoliosis survey in infant/child with congenital scoliosis or under the age of 10 (ACR, 2018; Strahle, 2015).~~
- ~~Any combination of these for spinal survey in patient with metastases.~~
- ~~For evaluation of spinal abnormalities associated with Arnold-Chiari Malformation and Spine MRI is contraindicated. (C/T/L spine due to association with tethered cord and syringomyelia) (Milhorat, 2009; Strahle, 2015).~~

- ~~Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or cutaneous stigmata (AANS; Duz, 2008; Milhorat, 2009), when anesthesia required for imaging and **MRI is contraindicated.**~~
- ~~Drop metastasis from brain or spine **when MRI contraindicated** (imaging also includes brain; CT spine imaging in this scenario is usually CT myelogram).~~
  ~~CSF leak highly suspected and supported by patient history and/or physical exam findings~~

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

Ankylosing Spondylitis/Spondyloarthropathies ~~is a~~**can** cause ~~of~~ back or sacroiliac pain of insidious onset (usually > 3 month), associated with morning stiffness not relieved with rest (usually age at onset <40). ~~It is~~**They are** associated with any of the following (Akgul, 2011; Bennett, 2010; Ostergaard, 2012; S**ie**~~e~~iper, 2014):

- Sedimentation rate and/or C-reactive protein (not an essential criteria)~~.~~
- HLA B27 (not an essential criteria)~~.~~
- Non-diagnostic or indeterminate x-ray
- Personal or family history of sacroilitis, peripheral inflammatory arthritis, and/or inflammatory bowel disease.

***Conservative Therapy:** (S~~s~~pine) should include a multimodality approach consisting of a **combination of active and inactive components**. Inactive components, such as rest, ice, heat, modified activities, medical devices, acupuncture and/or stimulators, medications, injections (epidural, facet, bursal, and/or joint, not including trigger point), and diathermy can be utilized. Active modalities may consist of physical therapy, a ~~physician~~ **physician** supervised home exercise program**, regular o~~O~~steopathic m~~M~~anipulative medicine treatments **(OMT)**, and/or chiropractic care **when considered safe and appropriate**. ~~.~~

****Home Exercise Program - (HEP)/Therapy** – the following elements are required to meet guidelines for completion of conservative therapy (ACR, 2015; Last, 2009):

- Information provided on exercise prescription/plan AND

- Follow-up with member with documentation provided regarding lack of improvement (failed) after completion of HEP (after suitable 6-week period), or inability to complete HEP due to physical reason- i.e., increased pain, inability to physically perform exercises. (Patient inconvenience or noncompliance without explanation does not constitute "inability to complete" HEP).
- Dates and duration of failed PT, physician-supervised HEP, or chiropractic treatment should be documented in the original office notes or an addendum to the notes.

Table 1: Gait and spine imaging‡

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
Ataxic	Broad based, clumsy, staggering, lack of coordination, usually also with limb ataxia	Brain imaging
Apraxic	Magnetic, shuffling, difficulty initiating	Brain imaging
Parkinsonian	Stooped, small steps, rigid, turning en bloc, decreased arm swing	Brain Imaging
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→ foot drop Lumbar spine MRI Pelvis MR appropriate evidence of plexopathy
Vestibular	Insecure, veer to one side, worse when eyes closed, vertigo	Consider Brain/IAC MRI as per GL

(‡References: Chhetri, 2014; Clinch, 2021; Gait, 2021; Haynes, 2018; Marshall, 2012; Pirker, 2017)

Gait and spine imaging:

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
Ataxic	Broad based, clumsy, staggering, lack of coordination, usually also with limb ataxia	Brain imaging
Apraxic	Magnetic, shuffling, difficulty initiating	Brain imaging
Parkinsonian	Stooped, small steps, rigid, turning en bloc, decreased arm swing	Brain Imaging
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 imagng) imaging based on EMG
Neurogenic	Steppage, dragging of toes	EMG → foot drop Lumbar spine MRI Pelvis MR appropriate evidence of plexopathy
Vestibular	Insecure, veer to one side, worse when eyes closed, vertigo	Consider Brain/IAC MRI as per GL

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%) (Vitzthum, 2007).

CT and Infection of the spine - Infection of the spine is not easy to differentiate from other spinal disorders, e.g., degenerative disease, spinal neoplasms, and non-infective inflammatory lesions. Infections may affect different parts of the spine, e.g., vertebrae, intervertebral discs, and paraspinal tissues. Imaging is important to obtain early diagnosis and treatment to avoid permanent neurology deficits. When MRI is contraindicated, CT may be used to evaluate infections of the spine.

CT and Degenerative Disc Disease – Degenerative disc disease is very common and CT may be indicated when MRI is contraindicated, when chronic degenerative changes are accompanied by conditions, e.g., new neurological deficits; onset of joint tenderness of a localized area of the spine; new abnormal nerve conductions studies; exacerbation of chronic back pain unresponsive to conservative treatment; and unsuccessful physical therapy/home exercise program.

Infection, Abscess, or Inflammatory disease

- Most common site is the lumbar spine (58%), followed by the thoracic spine (30%) and the cervical spine (11%) (Graeber, 2019)
- High risk populations (indwelling hardware, history of endocarditis, IVDA, recent procedures) with appropriate signs/symptoms

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 ~~due to~~**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 or nondiagnostic, brachial plexus injury in neonates, radiation therapy treatment planning, and cerebrospinal fluid (CSF) leak (Pomerantz, 2016).

Cauda Equina Syndrome

- Symptoms include severe back pain or sciatica along with one or more of the following:
    - Saddle anesthesia - loss of sensation restricted to the area of the buttocks, perineum, and inner surfaces of the thighs (areas that would sit on a saddle)~~.~~
    - Recent bladder/bowel dysfunction ~~(as listed above)~~
    - Achilles reflex absent on both sides
    - Sexual dysfunction that can come on suddenly
    - Absent anal reflex and bulbocavernosus reflex

~~**MRI and Cutaneous Stigmata** (Dias, 2015)~~

TABLE 1 Risk Stratification for Various Cutaneous Markers

High Risk	Intermediate Risk	Low Risk
Hypertrichosis	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
Infantile hemangioma		Light hair
Atretic meningocele		Isolated café au lait spots
DST		Mongolian spots
Subcutaneous lipoma		Hypo- and hypermelanotic macules or papules
Caudal appendage		Deviated or forked gluteal cleft
Segmental hemangiomas in association with LUMBAR syndrome		Nonmidline lesions

LUMBAR, lower body hemangioma and other cutaneous defects, urogenital abnormalities, ulcerations, myelopathy, bony defects, anorectal malformations, arterial anomalies, and renal anomalies.

Back Pain with Cancer History - 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) include~~:~~ primary bone neoplasms, such as hemangioma or giant cell tumors, and tumor-like conditions causing bony and cellular remodeling, such as aneurysmal bone cysts, or Paget's disease (osteitis deformans); infiltrative neoplasms, including and not limited to, multiple myeloma and lymphoma, and metastatic neoplasms (ACR, 2018).

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 (Ziu, 2019).

Table 2: MRI and Cutaneous Stigmata (Dias, 2015)

Risk Stratification for Various Cutaneous Markers		
High Risk	**Intermediate Risk**	**Low Risk**
• Hypertrichosis • Infantile hemangioma • Artretic meningocele	• Capillary malformations (also referred to as NFS or salmon patch when pink and poorly	• Coccygeal dimple • Light hair • Isolated café au lait spots • Mongolian spots

• DST • Subcutaneous lipoma • Caudal appendage • Segmental hemangiomas in association with LUMBAR‡ syndrome	defined or PWS when darker red and well-defined)	• 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
April 2021	• Added/modified ○ Modified section on neurological deficits ○ Back pain in a child added/modified red flags ○ Gait table in background ○ Post-surgical modified/clarified surgical criteria for combination exams and surgeon preference for exam type ○ Removed myelopathy combination studies ○ Updated/added MS Criteria ▪ Combination section for initial imaging and follow up ▪ Added pediatric MS ○ Modified known tumor imaging into primary and metastatic disease ○ Added toe walking for pediatric patients ○ Modified Combination exam wording
May 2020	• For evaluation of neurologic deficits when new deficits are present • Removed pars defect section • Added ankylosing spondylitis for evaluation of trauma/acute injury • Modified Initial imaging of new or increasing non-traumatic back pain or radiculopathy or back pain that occurs at night and wakes the patient from sleep with known active cancer and a tumor that tends to metastasize to the spine • Added Imaging of Ossification of the Posterior Longitudinal Ligament (OPPL)

	• Added Osteopathic Manipulative medicine to conservative care therapy
June 2019	• Added: ○ new or worsening objective neuro deficits for chronic and acute back pain; CSF leak ○ last 6 months for allowable post op f/u period and removed EMG comment ○ red flags specifically for peds back pain and pain related to malignancy, infection, inflammation ○ new sections: pars defect; compression fractures; congenital abnormalities including section on scoliosis and vertebral anomalies in children w/back pain; ○ For combination studies cervical/thoracic/lumbar added drop metastasis, tumor evaluation for neurocutaneous syndromes, and abnormalities associated w/Arnold Chiari, as well as separate indication for tethered cord or spinal dysraphism ○ Spinal cord stimulator ○ New or increasing back pain in cancer patients with high suspicion of mets

~~June 2019~~

- ~~Added:~~
  - ~~new or worsening objective neuro deficits for chronic and acute back pain; CSF leak~~
  - ~~last 6 months for allowable post op f/u period and removed EMG comment~~
  - ~~red flags specifically for peds back pain and pain related to malignancy, infection, inflammation~~
  - ~~new sections: pars defect; compression fractures; congenital abnormalities including section on scoliosis and vertebral anomalies in children w/back pain;~~
  - ~~For combination studies cervical/thoracic/lumbar added drop metastasis, tumor evaluation for neurocutaneous syndromes, and abnormalities associated w/Arnold Chiari, as well as separate indication for tethered cord or spinal dysraphism~~
  - ~~Spinal cord stimulator~~
  - ~~New or increasing back pain in cancer patients with high suspicion of mets~~

~~May 2020~~

- ~~For evaluation of neurologic deficits when new deficits are present~~
- ~~Removed pars defect section~~
- ~~Added ankylosing spondylitis for evaluation of trauma/acute injury~~
- ~~Modified Initial imaging of new or increasing non-traumatic back pain or radiculopathy or back pain that occurs at night and wakes the patient from sleep with known active cancer and a tumor that tends to metastasize to the spine~~

- Added Imaging of Ossification of the Posterior Longitudinal Ligament (OPPL)
- Added Osteopathic Manipulative medicine to conservative care therapy

April 2021

- Added/modified
  - Modified section on neurological deficits
  - Back pain in a child added/modified red flags
  - Gait table in background
  - Post-surgical modified/clarified surgical criteria for combination exams and surgeon preference for exam type
  - Removed myelopathy combination studies
  - Updated/added MS Criteria
    - Combination section for initial imaging and follow up
    - Added pediatric MS
  - Modified known tumor imaging into primary and metastatic disease
  - Added toe walking for pediatric patients
  - Modified Combination exam wording

REFERENCES

Acharya AB, Fowler JB. Chaddock Reflex. [Updated 2019 Dec 15]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2020 Jan. https://www.ncbi.nlm.nih.gov/books/NBK519555/.

Akgul O, Ozgocmen S. Classification criteria for spondyloarthropathies. *World J Orthop.* Dec 18, 2011; 2(12):107-115. doi: 10.5312/wjo.v2.i12.07. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3302034/. Retrieved March 29, 2018.

Alexandru D. Evaluation and management of vertebral compression fractures. *Perm J.* Published online October 30, 2012:46-51. doi:10.7812/TPP/12-037.

Allegri M, Montella S, Salici F, et al. Mechanisms of low back pain: A guide for diagnosis and therapy. *F1000Res*. 2016 Oct; 2.

American Association of Neurological Surgeons (AANS). Tethered spinal cord syndrome. 2019.

American Association of Neurological Surgeons and Congress of Neurological Surgeons (AANSCNS). Choosing Wisely®. http://www.choosingwisely.org/clinician-lists/american-association-neurological-surgeons-imaging-for-nonspecific-acute-low-back-pain/. Released June 24, 2014.

American College of Radiology (ACR). ACR Appropriateness Criteria®. Published 2015.

American College of Radiology (ACR). ACR Appropriateness Criteria®. Inflammatory Back Pain: Known or Suspected Axial Spondyloarthritis. https://acsearch.acr.org/docs/3094107/Narrative/. Revised 2021.

Ando K, Imagama S, Kobayashi K, et al. Clinical features of thoracic myelopathy: A single-center study. *J Am Acad Orthop Surg Glob Res Rev*. 2019 Nov; 3(11):e10.5435.

Behrbalk E, Salame K, Regev GJ, et al. Delayed diagnosis of cervical spondylotic myelopathy by primary care physicians. *Neurosurg Focus*. July 2013; 35(1):1-6.

Bennett AN, Marzo-Ortega H, Rehman A, et al. The evidence for whole-spine MRI in the assessment of axial spondyloarthropathy. *Rheumatology*. March 2010; 49(3):426-432. https://doi.org/10.1093/rheumatology/kep427. https://academic.oup.com/rheumatology/article/49/3/426/1787410. Retrieved May 12, 2018.

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.* 2015 Sep 15; 61(6):e26–e46.

Bernstein RM, Cozen H. Evaluation of back pain in children and adolescents. *Am Fam Physician*. 2007;76(11):1669-1676.

Bond A, Manian FA. Spinal epidural abscess: A review with special emphasis on earlier diagnosis. *Biomed Res Int*. 2016; 2016:1614328.

Budoff MJ, Khairallah W, Li D, et al. Trabecular bone mineral density measurement using thoracic and lumbar quantitative computed tomography. *Aca Radiology*. 2012; 19(2):179-183. doi: 10.1016/j.acra.2011.10.006.

Chhetri SK, Gow D, Shaunak S, Varma A. Clinical assessment of the sensory ataxias; diagnostic algorithm with illustrative cases. *Pract Neurol*. 2014;14(4):242-251. doi:10.1136/practneurol-2013-000764.

Choi BW, Song KJ, Chang H. Ossification of the posterior longitudinal ligament: A review of literature. *Asian Spine J*. 2011; 5(4):267–276. doi:10.4184/asj.2011.5.4.267

Choosing Wisely®. Lists. http://www.choosingwisely.org/clinician-lists/#keyword=spine&topic-area=Radiology&service=Imaging. Retrieved March 27, 2018.

Clinch J, Wood M, Driscoll S. Evaluation of gait disorders in children. BMJ Best Practice. Published February 23, 2021. Accessed July 14, 2021. https://bestpractice.bmj.com/topics/en-us/709.

D' Alessandro. Does This Sacral Dimple Need to be Evaluated? PediatricEducation.org™. https://pediatriceducation.org/2009/07/20/does-this-sacral-dimple-need-to-be-evaluated/. Posted July 20, 2009. Retrieved March 29, 2018.

Davies BM, Mowforth OD, Smith EK, et al. Degenerative cervical myelopathy. *BMJ*. 2018; 360. doi: https://doi.org/10.1136/bmj.k186.

Dias M, Partington M. Congenital brain and spinal cord malformations and their associated cutaneous markers. *Pediatrics.* 2015; 136(4):e1105-19.

Duz B, Gocmen S, Secer HI, et al. Tethered cord syndrome in adulthood. *J Spinal Cord Med.* 2008; 31(3):272-278. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2565560/. Retrieved March 29, 2018.

Eubanks JD. Cervical radiculopathy: Nonoperative management of neck pain and radicular symptoms. *Am Fam Physician*. 2010 Jan 1; 81(1):33-40. **https://www.aafp.org/afp/2010/0101/p33.pdf.**

Feldman DS, Straight JJ, Badra MI, Mohaideen A, Madan SS. Evaluation of an algorithmic approach to pediatric back pain. *J Pediatr Orthop*. 2006;26(3):353-357. doi:10.1097/01.bpo.0000214928.25809.f9.

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*. 2013;206(6):987-993; discussion 993-994. doi:10.1016/j.amjsurg.2013.08.021.

Gait abnormalities. Stanford Medicine 25. Published 2021. Accessed July 14, 2021. https://stanfordmedicine25.stanford.edu/the25/gait.html.

Graeber A, Cecava ND. Vertebral Osteomyelitis. [Updated 2019 Jun 3]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2020 Jan.

Haynes KB, Wimberly RL, VanPelt JM, Jo C-H, Riccio AI, Delgado MR. Toe walking: A neurological perspective after referral from pediatric orthopaedic surgeons. *Journal of Pediatric Orthopaedics*. 2018;38(3):152-156. doi:10.1097/BPO.0000000000001115.

Hertzler DA, DePowell JJ, Stevenson CB, Mangano FT. Tethered cord syndrome: A review of the literature from embryology to adult presentation. *Neurosurg Focus*. 2010;29(1):E1. doi:10.3171/2010.3.FOCUS1079.

Hitson WJ, Lane JR, Bauer DF, et al. A prospective natural history study of nonoperatively managed Chiari I malformation: Does follow-up MRI surveillance alter surgical decision making? *J Neurosurg Pediatr*. 2015 Aug; 16(2):159-66.

Hou X, Sun C, Liu X, et al. Clinical features of thoracic spinal stenosis-associated myelopathy: A retrospective analysis of 427 cases. Clin Spine Surg. 2016 Mar; 29(2):86-9. doi: 10.1097/BSD.0000000000000081.

Jarvik JG, Gold LS, Comstock BA, et al. Association of early imaging for back pain with clinical outcomes in older adults. *JAMA*. 2015; 313(11):1143-1153. doi: 10.1001/jama.2015.1871.

Kim YS, Han IH, Lee IS, et al. Imaging findings of solitary spinal bony lesions and the differential diagnosis of benign and malignant lesions. *J Korean Neurosurg Soc.* August 2012; 52(2):126-132. doi: 10.3340/jkns.2012.52.2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3467370/. Retrieved March 29, 2018.

Koivikko MP, Koskinen SK. MRI of cervical spine injuries complicating ankylosing spondylitis. Skeletal Radiol. 2008 Sep; 37(9):813-9. doi:10.1007/s00256-008-0484-x. Epub 2008 Apr 18.

Last AR, Hulbert K. Chronic low back pain: Evaluation and management. *Am Fam Physician*. 2009; 79(12):1067-74.

Lerner S, Hartmann S, Barbagallo GMV, et al. Management of spinal infection: A review of the literature. *Acta Neurochir (Wien).* 2018; 160(3):487–496. doi: 10.1007/s00701-018-3467-2.

Marshall FJ. Approach to the elderly patient with gait disturbance. *Neurol Clin Pract*. 2012;2(2):103-111. doi:10.1212/CPJ.0b013e31825a7823.

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.* July 1, 2009; 72(1):20-35. http://europepmc.org/abstract/med/19559924. Retrieved March 29, 2018.

Muller D, Bauer JS, Zeile M, et al. Significance of sagittal reformations in routine thoracic and abdominal multislice CT studies for detecting osteoporotic fractures and other spine abnormalities. *Eur Radiol*. 2008; 18(8):1696-1702. doi: 10.10007/s00330-008-0920-2.

North American Spine Society (NASS). Clinician Lists. Choosing Wisely®. http://www.choosingwisely.org/clinician-lists/nass-emg-nerve-conduction-studies-to-determine-cause-of-spine-pain/. Released October 9, 2013.

North American Spine Society (NASS). Evidence-based Clinical Guidlines for Multidisciplinary Spine Care. Diagnosis and Treatment of Cervical Radiculopathy from Degenerative Disorders. 2010 North American Spine Society. https://www.spine.org/Portals/0/Assets/Downloads/ResearchClinicalCare/Guidelines/CervicalRadiculo pathy.pdf~~North American Spine Society (NASS). Diagnosis and treatment of cervical radiculopathy from degenerative disorders. 2010.~~

North American Spine Society (NASS). Five Things Physicians and Patients Should Question. Choosing Wisely®. http://www.choosingwisely.org/doctor-patient-lists/north-american-spine-society/. 2014.

Ostergaard M, Lambert RG. Imaging in ankylosing spondylitis. *Ther Adv Musculoskelet Dis*. August 2012; 4(4):301-311. doi: 10.1177/1759720X11436240. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3403247/. Retrieved March 29, 2018.

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*. 2010;34(4):543-546. doi:10.1007/s00264-009-0817-y.

Pirker W, Katzenschlager R. Gait disorders in adults and the elderly: A clinical guide. *Wien Klin Wochenschr*. 2017;129(3-4):81-95. doi:10.1007/s00508-016-1096-4.

Pomerantz SR. Myelography: Modern technique and indications. *Handb Clin Neurol*. 2016; 135:193-208.

Radic JAE, Cochrane DD. Choosing wisely canada: pediatric neurosurgery recommendations. *Paediatr Child Health*. 2018;23(6):383-387. doi:10.1093/pch/pxy012.

Rao D, Scuderi G, Scuderi C, Grewal R, et al. The use of imaging in management of patients with low back pain. *J Clin Imaging Sci*. 2018 Aug 24; 8:30.

Scoliosis Research Society (SRS). Conditions and treatments: Juvenile scoliosis. 2019.

Shah LM, Salzman KL. Imaging of spinal metastatic disease. *Int J Surg Oncol*. 2011; 2011:769753.

Sieper J, Rudwaleit M, Baraliakos X, et al. The assessment of SpondyloArthritis international Society (ASAS) handbook: A guide to assess spondyloarthritis. *Ann Rheum Dis*. June 2009; 68 Suppl 2:ii1-44.

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*. 2013;81(20):1789-1792. doi:10.1212/01.wnl.0000435555.13695.22.

Stolper K, Haug JC, Christensen CT, et al. Prevalence of thoracic spine lesions masquerading as cauda equina syndrome: yield of a novel magnetic resonance imaging protocol. *Intern Emerg Med*. 2017 Dec; 12(8):1259-1264. doi: 10.1007/s11739-016-1565-9.

Strahle J, Muraszko KM, Kapurch J, Bapuraj JR, Garton HJL, Maher CO. Chiari malformation Type I and syrinx in children undergoing magnetic resonance imaging. *J Neurosurg Pediatr*. 2011;8(2):205-213. doi:10.3171/2011.5.PEDS1121.

Strahle J, Smith BW, Martinez M, et al. The association between Chiari malformation Type I, spinal syrinx, and scoliosis. *J Neurosurg Pediatr*. 2015; 15:607-611. http://thejns.org/doi/pdf/10.3171/2014.11.PEDS14135. Retrieved March 29, 2018.

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*. 2009;193(3 Suppl):S10-19, Quiz S20-24. doi:10.2214/AJR.07.7102.

Teoli D, Rocha Cabrero F, Ghassemzadeh S. Lhermitte Sign. In: *StatPearls*. StatPearls Publishing; 2021. Accessed July 15, 2021. http://www.ncbi.nlm.nih.gov/books/NBK493237/

Timpone V, Patel SH. MRI of a syrinx: Is contrast material always necessary? Am J Roentgenol. 2015; 204:1082-1085. 10.2214/AJR.14.13310.

Trenga AP, Singla A, Feger MA, et al. Patterns of congenital bony spinal deformity and associated neural anomalies on X-ray and magnetic resonance imaging. *J Child Orthop*. August 2016; 10(4):343-352. doi: 10.1007/s11832-016-0752-6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4940247/. Retrieved March 29, 2018.

Vilaca C, Orsini M, Leite MAA, et al. Cervical spondylotic myelopathy: What the neurologist should know. *Neurol Int*. 2016 Nov 2; 8(4):6330. doi: 10.4081/ni.2016.6330.

Vitzthum H, Dalitz K. Analysis of five specific scores of cervical spondylogenic myelopathy. *Eur Spine J*. December 2007; 16(12):2096-2103. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2140133/.

Waly FJ, Abduljabbar FH, Fortin M, et al. Preoperative computed tomography myelography parameters as predictors of outcome in patients with degenerative cervical myelopathy: Results of a systematic review. *Global Spine J*. 2017; 7(6):521–528. doi:10.1177/2192568217701101.

Ziu E, Viswanathan VK, Mesfin FB. Cancer, Spinal Metastasis. [Updated 2020 Mar 30]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2020 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK441950/.

Reviewed / Approved by M. Atif Khalid MD M. Atif Khalid, M.D., Medical Director, Radiology

Reviewed / Approved by ee

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.