AmeriHealth Caritas Louisiana

National Imaging Associates, Inc.*	
Clinical guideline **CERVICAL SPINE CT**	**Original Date: September 1997**
CPT Codes: 72125, 72126, 72127	**Last Revised Date: May 2020**
Guideline Number: NIA_CG_041	**Implementation Date: ~~January 2021~~TBD**

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. All prior relevant imaging results, and the reason that alternative imaging (gold standard, protocol, contrast, etc.) cannot be performed must be included in the documentation submitted.

INDICATIONS FOR CERVICAL SPINE CT:

For evaluation of back pain with any of the following when **Cervical** Spine MRI is contraindicated (Allegri, 2016)

- With new or worsening objective neurologic deficits on exam
- 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 cervical radiculopathy. (EMG is not recommended to determine the cause of axial lumbar, thoracic, or cervical spine pain (NASS, 2013)).

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

- 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*.
- When the patient is clinically unevaluable or there are preliminary imaging findings (X-ray or CT) needing further evaluation.
- History of underlying spinal abnormalities (i.e. ankylosing spondylitis) (Koivikko, 2008)

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

- When office notes specify the patient meets NEXUS (National Emergency X-Radiography Utilization Study) or CCR (Canadian Cervical Rules) criteria for imaging (ACR, 2018):
    - CT for initial imaging.
    - MRI when suspect spinal cord or nerve root injury or when patient is obtunded, and CT is negative.
    - CT or MRI for treatment planning of unstable spine.

("MRI and CT provide complementary information. When indicated It is appropriate to perform both examinations" (ACR, 2018)).

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

- 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.

For evaluation of known fracture
(ACR, 2012)

- 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 Cervical Spine MRI is contraindicated or inappropriate~~
~~(ACR, 2013; NASS, 2010)~~

- ~~With any of the following new neurological deficits: extremity 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 not preformed~~ when MRI is contraindicated (ACR, 2019; NASS, 2010)

- Demonstration of the site of a CSF leak (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.
- Evaluation of suspected brachial plexus or nerve root injury in the neonate

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 suspected myelopathy when Cervical Spine MRI is contraindicated
(ACR, 2015; Behrbalk, 2013; **Davies, 2018;** Vilaca, 2016**; Waly, 2017**~~; Davies, 2018~~)

- 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 (Signs: unsteadiness, broad-based gait, increased muscle tone, weakness and wasting of the upper and lower limbs; diminished sensation to light touch, temperature, proprioception, vibration; limb hyperreflexia and pathologic reflexes; bowel and bladder dysfunction in more severe cases).

~~**For evaluation of chronic neck pain, with any of the following when Cervical Spine MRI is contraindicated** (Allegri, 2016)~~

- ~~With new or worsening objective neurologic deficits on exam~~
- ~~Failure of conservative treatment* for at least six (6) weeks (ACR, 2013; Eubanks, 2010) within the last six (6) months.~~
- ~~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 cervical radiculopathy. (EMG is not recommended to determine the cause of axial lumbar, thoracic or cervical spine pain (NASS, 2013)).~~

~~**For evaluation of new onset of neck pain when Cervical Spine MRI is contraindicated** (Allegri, 2016):~~

- ~~With new or worsening objective neurologic deficits on exam~~
- ~~Failure of conservative treatment*, for at least six (6) weeks (ACR, 2013; Eubanks, 2010) within the last six (6) months.~~
- ~~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 cervical radiculopathy. (EMG is not recommended to determine the cause of axial lumbar, thoracic or cervical spine pain (NASS, 2013)).~~

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

- ~~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*.~~
- ~~When the patient is clinically unevaluable or there are preliminary imaging findings (X-ray or CT) needing further evaluation.~~
- ~~History of underlying spinal abnormalities (i.e. ankylosing spondylitis)~~
- ~~When office notes specify the patient meets NEXUS (National Emergency X-Radiography Utilization Study) or CCR (Canadian Cervical Rules) criteria for imaging (ACR, 2018):~~
    - ~~CT for initial imaging.~~
    - ~~MRI when suspect spinal cord or nerve root injury or when patient is obtunded, and CT is negative.~~

~~○ CT or MRI for treatment planning of unstable spine.~~
~~(MRI and CT provide complementary information. When indicated It is appropriate to perform both examinations" (ACR, 2018)).~~

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 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 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.
- Initial imaging of new or increasing non-traumatic neck pain or radiculopathy or neck 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 when MRI cannot be done (ACR, 2018; Ziu, 2019).

For evaluation of suspected tumor when Cervical 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 Cervical Spine MRI is contraindicated
(ACR, 2018)

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

    - Follow up imaging of infection
        - With worsening symptoms/laboratory values (i.e., white blood cell count, ESR/CRP) or radiographic findings (Berbari, 2015)
- In rheumatoid arthritis with neurologic signs/symptoms, or evidence of subluxation on radiographs (lateral radiograph in flexion and neutral should be the initial study) (Colebatch, 2013; Tehranzadeh, 2017)
    - Patients with negative radiographs but symptoms suggestive of cervical instability or in patients with neurologic deficits.
- High risk disorders affecting the atlantoaxial articulation, such as Down syndrome, Marfan syndrome with neurological signs/symptoms, abnormal neurological exam, or evidence of abnormal or inconclusive radiographs of the cervical spine (Henderson, 2017)
- ~~As evidenced by signs/symptoms, laboratory or prior imaging findings.~~

For evaluation of spine abnormalities related to immune system suppression, e.g., HIV, chemotherapy, leukemia, or lymphoma when Cervical Spine MRI is contraindicated (ACR, 2015; Nagashima, 2010~~; ACR, 2015~~)

- 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~~ Upper extremity weakness, objective sensory loss, or abnormal reflexes (Rao, 2018).

Other Indications for a Cervical Spine CT:

- For preoperative evaluation and Cervical Spine MRI is contraindicated
- CT discogram~~. -- Investigation of persistent, severe symptoms that do not correlate with equivocal or inconsistent MR imaging or CT findings; Assessment of disc prior to fusion to determine if a disc within proposed fusion segment is symptomatic; Assessment of post-surgical failed back syndrome of patients in whom MR imaging is non-diagnostic.~~
- ~~Suspected cord compression with any of the following neurological deficits: extremity weakness; sensory deficits, abnormal gait; abnormal reflexes; spinal level; bowel or bladder incontinence and Cervical Spine MRI is contraindicated~~
- Tethered cord, or spinal dysraphism (known or suspected) based on preliminary imaging, neurological exam, and/or ~~high risk~~high-risk cutaneous stigmata (AANS; Duz, 2008; Milhorat, 2009; NIH), and MRI is contraindicated.
- Known Arnold-Chiari syndrome and Cervical Spine MRI is contraindicated.

- Congenital abnormalities in the presence of neurologic deficit, progressive spinal deformity, or for preoperative planning (Trenga, 2016) when MRI is contraindicated or for characterization of bony detail.
- Syrinx or syringomyelia (known or suspected) and Cervical 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 and MRI is contraindicated (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.
    - Back pain associated with suspected inflammation, infection, or malignancy
- In rheumatoid arthritis with neurologic signs or symptoms, evidence of subluxation or positive radiograph (lateral radiograph in flexion and neutral should be the initial study) when MRI is contraindicated or for surgical treatment planning (Colebatch, 2013)

COMBINATION ~~OF~~ STUDIES WITH CERVICAL SPINE CT:

Cervical/Thoracic/Lumbar CTs:

- CT myelogram **when MRI is contraindicated** ~~or~~
- **Post-procedure (**discogram**) CT**.
- Any combination of these for scoliosis survey in infant/child with congenital scoliosis or under the age of 10 **(ACR, 2018** ~~(~~**;** Strahle, 2015 ~~; ACR, 2018~~).
- Any combination of these for spinal survey in patient with metastases.
- For evaluation of spinal abnormalities associated with Arnold-Chiari Malformation. (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 high risk cutaneous stigmata (~~AANS;~~ Duz, 2008; Milhorat, 2009~~;~~ ~~NIH~~), 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).

Cervical MRI/CT

- For unstable craniocervical junction.

Brain CT/Cervical CT

- For evaluation of Arnold-Chiari Malformation and Cervical Spine MRI is contraindicated.

BACKGROUND:

Computed tomography (CT) is performed for the evaluation of the cervical spine. CT may be used as the primary imaging modality or it may complement other modalities. Primary indications for CT include conditions, e.g., traumatic, neoplastic, and infectious. CT is often used to study the cervical spine for conditions such as degenerative disc disease when MRI is contraindicated. CT provides excellent depiction of bone detail and is used in the evaluation of known fractures of the cervical spine and for evaluation of postoperative patients.

OVERVIEW:

***Conservative Therapy:** (spine) 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 supervised home exercise program**, and/or osteopathic manipulative medicine (OMT) or chiropractic care.** ~~Active modalities may consist of physical therapy, a physician supervised home exercise program**, and/or chiropractic care.~~

****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.

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**

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%) (Vilaca, 2016).

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 neurologic 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 neck or back pain unresponsive to conservative treatment; and unsuccessful physical therapy/home exercise program.

Ossification Posterior Longitudinal Ligament (OPLL) (Choi, 2011) - Most common in cervical spine (rare but more severe in thoracic spine).

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 tumor can seed to the spine, the cancers mentioned above metastasize to the spinal column early in the disease process (Ziu, 2019).

Cervical Spine Trauma Imaging (ACR, 2018): The National Emergency X-Radiography Utilization Study (NEXUS) and the Canadian Cervical Rules (CCR) represent clinical criteria used to help determine the presence of significant cervical spine injury. Although the criteria are highly sensitive (99.6% for NEXUS), specificity is low (12.9% for Nexus).

A patient not meeting any of the NEXUS criteria of focal neurologic deficit, midline spinal tenderness, altered consciousness, intoxication or distracting injury is unlikely to have a significant cervical spine injury. Imaging evaluation of the cervical spine in these patients is not necessary. In the CCR criteria a patient without any high risk factors (Age >65 years, paresthesias in extremities, dangerous mechanism, falls from ≥3 feet/5 stairs, axial load to

head, motor vehicle crash with high speed, rollover, or ejection, bicycle collision, motorized recreational vehicle accident) is next evaluated for low risk factors (Simple rear-end motor vehicle crash, patient in sitting position in emergency center, patient ambulatory at any time after trauma, delayed onset of neck pain, absence of midline cervical spine tenderness). If the patient meets a low risk criteria, they are asked to move their head 45 degrees from midline in both directions. If the patient can accomplish this the spine is cleared and imaging is not necessary.

CT M~~m~~yelogram
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 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 (ACR, 2019; Pomerantz, 2016) .

POLICY HISTORY:
Review Date: June 2019
Review Summary:

- 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
    - CT myelogram
    - Rheumatoid arthritis
    - Specifics on neuro deficits including pathologic reflexes and spasticity, sensory, or motor level
    - Spinal trauma
    - New or increasing back pain in cancer patients with high suspicion of mets

Review Date: May 2020
Review Summary:

- **Added**
    - For evaluation of neurologic deficits when Cervical Spine MRI is contraindicated or inappropriate, added “new” deficits
    - Expanded CT myelogram indications

- Added Imaging of Ossification of the Posterior Longitudinal Ligament (OPPL)
- Added imaging in high risk patients predisposed to spinal injury
- Added imaging in high risk patients for atlantoaxial injury
- Added to background of imaging of infection
- Modified Initial imaging of new or increasing non-traumatic neck pain or radiculopathy or to include 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 Osteopathic Manipulative medicine to conservative care therapy

REFERENCES:

Allegri M, Montella S, Salici F, et al. Mechanisms of low back pain: A guide for diagnosis and therapy. *F1000Res*. 2016 Jun 28; 5:F1000 Faculty Rev-1530. doi:10.12688/f1000research.8105.2.

American College of Radiology (ACR). ACR Appropriateness Criteria®. ACR-ASNR-SPR Practice Parameter for the Performance of Myelography and Cisternography. Revised 2019.

American College of Radiology (ACR). ACR Appropriateness Criteria®. http://www.acr.org/Quality-Safety/Appropriateness-Criteria/Diagnostic. Published 2015.

American College of Radiology (ACR). ACR Appropriateness Criteria®. Suspected Spine Trauma. 2018.

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.

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):e26-46.

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

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.

Colebatch AN, Edwards CJ, Østergaard M, et al. EULAR recommendations for the use of imaging of the joints in the clinical management of rheumatoid arthritis. *Ann Rheum Dis*. 2013 Jun; 72(6):804-14.

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

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.

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

Henderson Sr FC, Austin C, Benzel E, et al. Neurological and spinal manifestations of the Ehlers-Danlos syndromes. Am J Med Genetics. Epub 2017 Feb 21.

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

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 2009; 72(1):20-35. http://europepmc.org/abstract/med/19559924.

Nagashima H, Yamane K, Nishi T, et al. Recent trends in spinal infections: Retrospective analysis of patients treated during the past 50 years. *Int Orthop.* March 2010; 34(3):395-399. doi: 10.1007/s00264-009-0741-1.

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

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). *Five Things Physicians and Patients Should Question*. Choosing Wisely®. http://www.choosingwisely.org/clinician-lists/north-american-spine-society-advanced-imaging-of-spine-within-first-six-weeks-of-non-specific-acute-low-back-pain/. Released October 9, 2013.

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

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

Sekula RF, Daffner RH, Quigley MR, et al. Exclusion of cervical spine instability in patients with blunt trauma with normal multidetector CT (MDCT) and radiography. *Br J Neurosurg.* 2008; 22(5):669-674. http://cranialdisorders.org/_pdfs/c-spine-multidetector-ct_2008.PDF.

Strahle J, Smith BW, Martinez M, et al. The association between Chiari malformation Type I, spinal syrinx, and scoliosis. *J Neurosurg Pediatr*. June 2015; 15(6):607-611. http://thejns.org/doi/pdf/10.3171/2014.11.PEDS14135. Retrieved March 29, 2018.

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. 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*. Dec. 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.

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