National Imaging Associates, Inc.*	
Clinical guidelines LUMBAR SPINE MRI	Original Date: September 1997
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INDICATIONS FOR LUMBAR SPINE MRI

(Combination requests at end of the document)

**For evaluation of neurologic deficits*
(Acharya, 2019; ACR, 2013; NASS, 2010; ~~Acharya, 2019,~~ ~~(~~Stolper, 2017)~~.)~~**

- **With any of the following new neurological deficits documented on physical exam**
  - **Extremity muscular weakness**
  - **Pathologic or abnormal reflexes**
  - **Absent/decreased sensory changes along a particular lumbar dermatome (nerve distribution): pin prick, touch, vibration, proprioception or temperature**
  - **Lower extremity increased muscle tone/spasticity**
  - **New onset bowel or bladder dysfunction (e.g., retention or incontinence)**
  - **Gait abnormalities (see ~~table below~~Table 1 for more details*)**
  - **New onset foot drop**

~~**Cauda Equina Syndrome as evidence by severe back pain/sciatica along with one of the defined symptoms (see Background section)**~~

~~**Cauda Equina Syndrome as evidence by severe back pain/sciatica along with one of the defined symptoms (see background section)**~~

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**For evaluation of back pain with any of the following
(AAFP, 2012; ACEP, 2014; ACR, 2015; Allegri, 2016; Ammendolia, 2015; Jarvik, 2015; Last, 2009; NASS, 2013; Quaseem, 2017; Schneider, 2019)**

- **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**
- **With progression or worsening of symptoms during the course of conservative treatment***

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

- With an abnormal electromyography (EMG) or nerve conduction study (if performed) indicating a lumbar radiculopathy. (EMG is not recommended to determine the cause of axial lumbar, thoracic, or cervical spine pain (NASS, 2013)).
- Isolated back pain in pediatric population (ACR, 2016) – conservative care not required if red flags present (see combination request below cervical and thoracic 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)

- For preoperative evaluation/planning.
- 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))
- 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 lumbar spine CT and MRI lumbar spine are both approvable (not an all-inclusive list):
        - 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 trauma or acute injury (ACR, 2018)

- Presents with any of the following neurological deficits * as above.

- With progression or worsening of symptoms during the course of conservative treatment*.
- History of underlying spinal abnormalities (i.e., ankylosing spondylitis or diffuse idiopathic skeletal hyperostosis) both MRI and CT are approvable. (Koivikko, 2008)
- 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") (ACR, 2018).

Pars defect (spondylolysis) or spondylolisthesis

- Pars defect (spondylolysis) or spondylolisthesis in adults when Flexion/Extension x-rays show instability.
- Clinically suspected Pars defect (spondylolysis) which is not seen on plain films in pediatric population (<18 yr) (flexion extension instability not required) and imaging would change treatment (Cohen, 2005; Kobayashi, 2013; Rush, 2015)

NOTE: Initial imaging (x-ray, or planar bone scan without SPECT; Bone scan with SPECT is superior to MRI and CT in the detection of pars intrarticularis pathology including spondylolysis) (Matesan, 2016).

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

- With history of malignancy
    - To aid in differentiation of benign osteopeorotic fractures from metastatic disease
        - A follow up MRI in 6-8 weeks after initial MRI when initial imaging cannot decipher benign osteopeorotic fracture from metastatic disease
- With an associated new focal neurologic deficit* as above
- Prior to a planned surgery/intervention or if the results of the MRI will change management.

For evaluation of tumor, cancer, or metastasis with any of the following (MRI is usually the preferred study, but CT may be needed to further characterize solitary indeterminate lesions seen on MRI)
(ACR, 2018; Kim, 2012; McDonald, 2019; Roberts, 2010)

Primary tumor

- Initial staging or re-staging of a known primary spinal tumor.
- Known primary 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 back pain or radiculopathy ~~or~~or back pain 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 (ACR, 2018; Ziu, 202~~019~~).

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 (ACR, 2018)

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 (ACR, 2015; 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)
- Spondyloarthropathies
  - Ankylosing Spondylitis/Spondyloarthropathies with non-diagnostic or indeterminate x-ray and rheumatology workup

For evaluation of spine abnormalities related to immune system suppression, e.g., HIV, chemotherapy, leukemia, or lymphoma (ACR, 2018)

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

Other Indications for a Lumbar Spine MRI (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 anorectal malformations (Kim, 2010a; Morimoto, 2003)
- Suspicious sacral dimple (those that are deep, larger than 0.5 cm, located within the superior portion of the gluteal crease or above the gluteal crease, multiple dimples, or associated with other cutaneous markers) (D'Alessandro, 2009) or duplicated or deviated gluteal cleft (Zywicke, 2011)
    - in patients <3 months should have ultrasound.
- 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))
- Known Chiari II (Arnold-Chiari syndrome), III, or IV malformation.
- For follow-up/repeat evaluation of Arnold-Chiari I with new signs or symptoms suggesting recurrent spinal cord tethering (For initial diagnosis see below)

COMBINATION OF STUDIES WITH LUMBAR SPINE MRI

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 MRIs:
- 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-~~w~~ 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 is 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)~~.~~
- Suspected ~~l~~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))

~~For evaluation of back pain with any of the following~~
~~(AAFP, 2012; ACEP, 2014; ACR, 2015; Allegri, 2016; Ammendolia, 2015; Jarvik, 2015; Last, 2009; NASS, 2013; Quaseem, 2017; Schneider, 2019)~~

- ~~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~~
- ~~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 lumbar radiculopathy. (EMG is not recommended to determine the cause of axial lumbar, thoracic, or cervical spine pain (NASS, 2013)).~~

~~For evaluation of neurologic deficits~~

- ~~With any of the following new neurological deficits: lower extremity muscular weakness; abnormal reflexes; abnormal sensory changes along a particular dermatome (nerve distribution) as documented on exam; evidence of Cauda Equina Syndrome; bowel or bladder dysfunction; new foot drop.~~

For evaluation of trauma or acute injury
(ACR, 2012; Quaseem, 2017)

- Presents with any of the following neurological deficits: radiculopathy, 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) (Koivikko, 2008)

Pars defect (spondylolysis) or spondylolisthesis

- Pars defect (spondylolysis) or spondylolisthesis in adults when Flexion/Extension x-rays show instability.
- Clinically suspected Pars defect (spondylolysis) which is not seen on plain films in pediatric population (<18 yr) (flexion extension instability not required) and imaging would change treatment (Cohen, 2005; Kobayashi, 2013; Rush, 2015)

NOTE: Initial imaging (x-ray, or planar bone scan without SPECT; Bone scan with SPECT is superior to MRI and CT in the detection of pars intrarticularis pathology including spondylolysis) (Matesan, 2016).

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

- With history of malignancy
    - To aid in differentiation of benign osteoperotic fractures from metastatic disease
        - A follow up MRI in 6-8 weeks after initial MRI when initial imaging cannot decipher benign osteoperotic fracture from metastatic disease
- With an associated new focal neurologic deficit
- Prior to a planned surgery/intervention or if the results of the MRI will change management.

For evaluation of known tumor, cancer, or evidence of metastasis with any of the following (Last, 2009) (MRI is usually the preferred study, but CT may help characterize solitary indeterminate bone lesions) (ACR, 2018; 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 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 (ACR, 2018; Ziu, 2019).

For evaluation of suspected tumor
(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
(ACR, 2018; Last, 2009; Lener, 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 spine abnormalities related to immune system suppression, e.g., HIV, chemotherapy, leukemia, or lymphoma
(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, 2018; 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 Lumbar Spine MRI**
- For preoperative evaluation.
- Suspected cord compression with any of the following neurological deficits: extremity weakness; sensory deficits, abnormal gait; abnormal reflexes; spinal level; bowel or bladder incontinence.
- 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).
    - Suspicious sacral dimple (those that are deep, larger than 0.5 cm, located within the superior portion of the gluteal crease or above the gluteal crease, or associated with

other cutaneous markers) (D'Alessandro, 2009) in patients <6 months should have ultrasound.

- For suspected Ankylosing Spondylitis/Spondyloarthropathies with non-diagnostic or indeterminate x-ray and rheumatology workup
- Known Arnold-Chiari syndrome (Milhorat, 2009; Strahle, 2015).
- Congenital abnormalities (Trenga, 2016):
    - In the presence of neurologic deficit, progressive spinal deformity, or for preoperative planning (Trenga, 2016)
    - Back pain in a child with vertebral anomalies (hemivertebrae, hypoplasia, agenesis, butterfly, segmentation defect, bars, or congenital wedging) seen on preliminary imaging.
    - Scoliosis with any of the following:
        - 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.
- CSF leak highly suspected and supported by patient history and/or physical exam findings.
- For pediatric population (ACR, 2016)
    - Red flags that prompt imaging should include one or more of the following: 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 OF STUDIES WITH LUMBAR SPINE MRI

Cervical/Thoracic/Lumbar MRIs:

- 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 metastasis.
- 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)
- Suspected Leptomeningeal carcinomatosis (LC) (Shah, 2011)
- 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.
- Drop metastasis from brain or spine (imaging also includes brain).
- Tumor evaluation and monitoring in neurocutaneous syndromes - See Background
- CSF leak highly suspected and supported by patient history and/or physical exam findings

BACKGROUND

Magnetic resonance imaging (MRI) is used in the evaluation, diagnosis, and management of ~~spine~~ spine-related conditions, e.g., degenerative disc disease, cauda equine compression, radiculopathy, infections, or cancer in the lumbar spine. MRI provides high quality multiplanar images of organs and structures within the body without the use of x-rays or radiation. In the lumbar area where gonadal exposure may occur, MRI's lack of radiation is an advantage.

OVERVIEW

Ankylosing Spondylitis/Spondyloarthropathies is a cause of back or sacroiliac pain of insidious onset (usually > 3 months), associated with morning stiffness not relieved with rest (usually age at onset < 40). It is associated with any of the following (Akgul, 2011; Bennett, 2010; Ostergaard, 2012; Sieei~~i~~per, 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~~.~~

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~~

***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.

****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~~

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

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 • 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.

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.

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**
-

MRI and Back Pain – MRI is the initial imaging modality of choice in the evaluation of complicated low back pain. Contrast administration may be used to evaluate suspected inflammatory disorders, e.g., discitis, and it is useful in evaluating suspected malignancy. Radiculopathy, disease of the nerve roots, is the most common indication for MRI of patients with low back pain. The nerve roots become irritated and inflamed, due to direct pressure from degenerative changes in the lumbar spine, creating pain and numbness. Symptoms of radiculopathy also include muscle weakness. MRI is indicated for this condition if the symptoms do not improve after conservative treatment over six weeks. MRI is also performed to evaluate Cauda equina syndrome, severe spinal compression.

Sacral Dimples - Simple midline dimples are the most commonly encountered dorsal cutaneous stigmata in neonates and indicate low risk for spinal dysraphism. Only atypical dimples are associated with a high risk for spinal dysraphism, particularly those that are large (>5 mm), high on the back (>2.5 cm from the anus) or appear in combination with other lesions (D' Alessandro, 2009). High-risk cutaneous stigmata in neonates include hemangiomas, upraised lesions (i.e., masses, tails, and hairy patches), and multiple cutaneous stigmata **(Table 2).**

Tethered spinal cord syndrome ~~–~~ This is a neurological disorder caused by tissue attachments that limit the movement of the spinal cord within the spinal column. Although this condition is rare, it can continue undiagnosed into adulthood. The primary cause is my~~l~~elomeningocele and lipomyelomeningocele; the following are other associations that vary in severity of symptoms and treatment.

- Dermal sinus tract (a rare congenital deformity)
- Diastematomyelia (split spinal cord)
- Lipoma
- Tumor
- Thickened/tight filum terminale
- History of spine trauma/surgery
- ~~Arnold~~ Arnold Chiari Malformation

Magnetic resonance imaging (MRI) can display the low level of the spinal cord and a thickened filum terminale, the thread-like extension of the spinal cord in the lower back. Treatment depends upon the underlying cause of the tethering. If the only abnormality is a thickened, shortened filum then limited surgical treatment may suffice.

Spina Bifida Occulta (AANS, 2020)

- Called the hidden spina bifida, as the spinal cord and the nerves are usually normal and there is no opening on the skin on the back.
- This subtype occurs in about 12% of the population and the majority of people are not aware that they have spina bifida occulta~~,~~ unless it is discovered on an x-ray performed for an unrelated reason.
- Approximately~~,~~ 1 in 1,000 individuals can have an occult structural finding that leads to neurological deficits or disabilities as bowel or bladder dysfunction, back pain, leg weakness or scoliosis.

Back Pain with Cancer - **History** Radiographic (x-ray) examination should be performed in cases of back pain when a patient has a cancer history. 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).

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 Neurocutaneous Syndromes

- In NF-1, clinical evaluation appears to be more useful to detect complications than is screening imaging in asymptomatic patients. Imaging is indicated in evaluation of suspected tumors based on clinical evaluation and for follow-up of known intracranial tumors (Borofsky, 2013).
- Conversely in NF-2, routine MR imaging screening is always indicated, given the high prevalence of CNS tumors, especially vestibular schwannomas. In patients with NF-2, routine screening brain/IAC imaging is indicated annually starting from age 10, if asymptomatic, or earlier with clinical signs/symptoms. Most individuals with NF2 eventually develop a spinal tumor, mostly commonly schwannomas, but meningioma and ependymomas are also seen. Spinal imaging at baseline and every 2 to 3 years is also advised with more frequent imaging, if warranted, based on sites of tumor involvement (Evans, 2017).
- In patients with Tuberous Sclerosis, Brain MRI should be obtained every 1-3 years up until age 25 for surveillance for CNS abnormalities (Krueger, 2013).
- In Von Hippel Lindau Syndrome, imaging of the brain and spinal cord for hemangioblastomas is recommended every 2 years (~~Von Hippel-Lindau~~**Varshney**, 2017).
- In Sturge Weber Syndrome, Brain MRI can rule out intracranial involvement ~~after~~ only after age 1 and is recommended in patients <1 year only if symptomatic (Comi, 2011).

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** ○ **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	• Added: ○ For evaluation of neurologic deficits added new deficits ○ Added ankylosing spondylitis for evaluation of trauma/acute injury ○ Added follow up of osteoperotic fracture from metastatic disease ○ Added Osteopathic Manipulative medicine to conservative care therapy ○ Added suspected leptomeningeal carcinomatosis to combination spine imaging ○ 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 ○ Modified Pars fracture to not seen on radiograph and imaging would change management ○ Added spina bifida occulta to background section
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

	• Expanded on tethered cord in Other Indications for imaging and added section on sacral dimple

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
- Expanded on tethered cord in Other Indications for imaging and added section on sacral dimple

Review Date: May 2020

Review Summary:

- **Added:**
  - For evaluation of neurologic deficits added new deficits
  - Added ankylosing spondylitis for evaluation of trauma/acute injury
  - Added follow up of osteoperotic fracture from metastatic disease
  - Added Osteopathic Manipulative medicine to conservative care therapy
  - Added suspected leptomeningeal carcinomatosis to combination spine imaging
  - 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
  - Modified Pars fracture to not seen on radiograph and imaging would change management
  - Added spina bifida occulta to background section

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
  - 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.

Akgul O, Ozgocmen S. Classification criteria for spondyloarthropathies. *World J Orthop.* December 18, 2011; 2(12):107-115. doi: 10.5312/wjo.v2.i12.07. 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 Jun 28; 5:F1000 Faculty Rev-1530. doi:10.12688/f1000research.8105.2.

Ammendolia C, Chow N. Clinical outcomes for neurogenic claudication using a multimodal program for lumbar spinal stenosis: A retrospective study. *J Manip Physiol Ther*. 2015; 38:188-194.

American Academy of Family Physicians (AAFP). Choosing Wisely®. http://www.choosingwisely.org/clinician-lists/#keyword=spine&topic-area=Radiology&service=Imaging. Released April 4, 2012. Retrieved March 27, 2018.

American Association of Neurological Surgeons (AANS). Spina Bifida. 2020.

American Association of Neurological Surgeons (AANS). Tethered Spinal Cord Syndrome. http://www.aans.org/Patients/Neurosurgical-Conditions-and-Treatments/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 Chiropractic Association (ACA). Five Things Physicians and Patients Should Question. Choosing Wisely®. http://www.choosingwisely.org/societies/american-chiropractic-association/. Published August 15, 2017.

American College of Emergency Physicians (ACEP). Ten Things Physicians and Patients Should Question. Choosing Wisely®. http://www.choosingwisely.org/societies/american-college-of-emergency-physicians/. Published October 27, 2014.

American College of Radiology (ACR). ACR Appropriateness Criteria® - Back Pain–Child. 2016.

American College of Radiology (ACR). ACR Appropriateness Criteria® - Low Back Pain. https://acsearch.acr.org/list. Published 2018.

American Institute of Ultrasound in Medicine (AIUM) Practice Parameter for the Performance of an Ultrasound Examination of the Neonatal and Infant Spine. https://www.acr.org/-/media/ACR/Files/Practice-Parameters/US-NeonatalSpine.pdf. Revised 2016.

Bennett AN, Marzo-Ortega H, Rehman A, et al. The evidence for whole-spine MRI in the assessment of axial spondyloarthropathy. *Rheumatology*. March 1, 2010; 49(3):426-432. https://doi.org/10.1093/rheumatology/kep427. 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.

Borofsky S, Levy LM. Neurofibromatosis: Types 1 and 2. *Am J Neuroradiol*. 2013 Dec; 34(12): 2250- 2251.

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.

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.

Cohen E, Stuecker RD. Magnetic resonance imaging in diagnosis and follow-up of impending spondylolysis in children and adolescents: Early treatment may prevent pars defects. *J Pediatr Orthop B.* 2005; 14(2):63-67.

Comi AM. Presentation, diagnosis, pathophysiology, and treatment of the neurological features of Sturge-Weber syndrome. *Neurologist*. 2011; 17(4):179.

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.

Davis PC, Wippold FJ, Brunberg JA, et al. ACR Appropriateness Criteria on low back pain. *J Am Coll Radiol.* 2009; 6:401-407. doi: 10.1016/j.jacr.2009.02.008.

Diab M, Landman Z, Lubicky J, et al. Use and outcome of MRI in the surgical treatment of adolescent idiopathic scoliosis. *Spine (Phila Pa 1976).* April 15, 2011; 36(8):667-671. doi: 10.1097/BRS.0b013e3181da218c.

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

De Vries M, Van Drumpt A, Van Royen B, et al. Discovertebral (Andersson) lesions in severe ankylosing spondylitis: a study using MRI and conventional radiography. *Clinical Rheumatology*. 2010; 29(12):1433-1438. doi: 10.1007/s10067-010-1480-9.

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.

Evans DGR, Salvador H, Chang VY, et al. Cancer and Central Nervous System Tumor Surveillance in Pediatric Neurofibromatosis 2 and Related Disorders. *Clin Cancer Res*. 2017; 23(12):e54.

Family Practice Notebook. Cutaneous Signs of Dysraphism. http://www.fpnotebook.com/nicu/Derm/CtnsSgnsOfDysrphsm.htm. Published 2015.

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.

Goh C, Phal PM, Desmond PM. Neuroimaging in acute transverse myelitis. *Neuroimaging Clin N Am*. 2011 Nov; 21(4):951-73.

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.

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.

Jensen AO, Jacobsen JB, Norgaard M, et al. Incidence of bone metastases and skeletal-related events in breast cancer patients: a population-based cohort study in Denmark. *BMC Cancer*. January 24, 2011; 11:29. http://www.ncbi.nlm.nih.gov/pubmed/21261987.

Kim SM, Chang HK, Lee MJ, et al. Spinal dysraphism with anorectal malformation: Lumbosacral magnetic resonance imaging evaluation of 120 patients. *Journal of Pediatric Surgery*. 2010a;45(4):769-776. doi:10.1016/j.jpedsurg.2009.10.094.

Kim H, Kim HS, Moon ES, et al. Scoliosis imaging: What radiologists should know. *RadioGraphics*. 2010b; 30:1823-1842. http://pubs.rsna.org/doi/pdf/10.1148/rg.307105061.

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.2012.52.2.126. Retrieved March 29, 2018.

Kobayashi A, Kobayashi T, Kato K, et al. Diagnosis of radiographically occult lumbar spondylolysis in young athletes by magnetic resonance imaging. *Am J Sports Med.* 2013; 41(1):169-176.

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.

Krueger DA, Northrup H. International Tuberous Sclerosis Complex Consensus Group. Tuberous sclerosis complex surveillance and management: Recommendations of the 2012 International Tuberous Sclerosis Complex Consensus Conference. *Pediatr Neurol*. 2013; 49(4):255.

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.

Lee C, Dorcil J, Radomisli TE. Nonunion of the spine: A review. *Clin Orthop Relat Res.* 2004; 419:71-75. https://www.ncbi.nlm.nih.gov/pubmed/15021134.

Malfair D, Flemming AK, Dvorak MF, et al. Radiographic evaluation of scoliosis: Review. *AJR Am J Roentgenol*. March 2010; 194(3 Suppl):S8-22. doi: 10.2214/AJR.07.7145.

Machado P, Landewé R, Braun J, et al. Both structural damage and inflammation of the spine contribute to impairment of spinal mobility in patients with ankylosing spondylitis. *Ann Rheum Dis*. 2010; 69(8):1465-1470. doi:10.1136/ard.2009.124206.

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

Matesan M, Behnia F, Bermo M, et al. SPECT/CT bone scintigraphy to evaluate low back pain in young athletes: common and uncommon etiologies. *J Orthop Surg Res*. 2016; 11:76.

McDonald MA, Kirsch CFE, Amin BY, et al. ACR Appropriateness Criteria® cervical neck pain or cervical radiculopathy. *J Am Coll Radiol*. 2019;16(5S):S57-S76. doi:10.1016/j.jacr.2019.02.023.

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.

Morimoto K, Takemoto O, Wakayama A. Tethered cord associated with anorectal malformation. *Pediatr Neurosurg*. 2003;38(2):79-82. doi:10.1159/000068048.

National Institute of Neurological Disorder and Stroke (NINDS). Tethered Spinal Cord Syndrome Information Page. https://www.ninds.nih.gov/Disorders/All-Disorders/Tethered-Spinal-Cord-Syndrome-Information-Page. Published 2011.

North American Spine Society (NASS). Clinician Lists. Choosing Wisely® . http://www.choosingwisely.org/clinician-lists/nass-emg-nerve-conduction-studies-to-determinecause-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/doctor-patient-lists/north-american-spine-society/. Published 2014.

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

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.

Qaseem A, Wilt TJ, McLean RM, et al. Noninvasive treatments for acute, subacute, and chronic low back pain: A clinical practice guideline from the American College of Physicians. *Ann Intern Med*. 2017 April 4.

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

Rajasekaran S, Kamath F, Kiran R, et al. Intraspinal anomalies in scoliosis: An MRI analysis of 177 consecutive scoliosis patients. *Indian J Orthop*. January-March 2010; 44(1): 57-63. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2822421/.

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.

Roberts CC, Daffner RH, Weissman BN, et al. ACR Appropriateness Criteria® on metastatic bone disease. *J Am Coll Radiol*. 2010;7(6):400-409. doi:10.1016/j.jacr.2010.02.015.

Rush JK, Astur N, Scott S, et al. Use of magnetic resonance imaging in the evaluation of spondylolysis. *J Pediatr Orthop*. 2015 Apr-May; 35(3):271-5.

Schneider MJ, Ammendolia C, Murphy DR, et al. Comparative clinical effectiveness of nonsurgical treatment methods in patients with lumbar spinal stenosis: A randomized clinical trial. *JAMA Netw Open*. 2019 Jan 4; 2(1):e186828.

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. Retrieved March 29, 2018.

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, 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.

Spondylitis Association of America (SAA). https://www.spondylitis.org/Ankylosing-Spondylitis/Diagnosis. 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.

Varshney N, Kebede AA, Owusu-Dapaah H, Lather J, Kaushik M, Bhullar JS. A review of Von Hippel-Lindau Syndrome. *J Kidney Cancer VHL*. 2017;4(3):20-29. doi:10.15586/jkcvhl.2017.88.

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/.

Zywicke HA, Rozzelle CJ. Sacral dimples. *Pediatr Rev*. 2011;32(3):109-113; quiz 114, 151. doi:10.1542/pir.32-3-109.

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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.