American College of Radiology
ACR Appropriateness Criteria®
Plexopathy

Variant: 1 Brachial plexopathy, acute or chronic, nontraumatic. No known malignancy. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
MRI brachial plexus without IV contrast	Usually Appropriate	O
MRI brachial plexus without and with IV contrast	Usually Appropriate	O
MRI cervical spine without and with IV contrast	May Be Appropriate	O
MRI cervical spine without IV contrast	May Be Appropriate	O
CT neck with IV contrast	May Be Appropriate	☢☢☢
US neck	Usually Not Appropriate	O
MRI brachial plexus with IV contrast	Usually Not Appropriate	O
MRI cervical spine with IV contrast	Usually Not Appropriate	O
CT cervical spine with IV contrast	Usually Not Appropriate	☢☢☢
CT cervical spine without and with IV contrast	Usually Not Appropriate	☢☢☢
CT cervical spine without IV contrast	Usually Not Appropriate	☢☢☢
CT neck without and with IV contrast	Usually Not Appropriate	☢☢☢
CT neck without IV contrast	Usually Not Appropriate	☢☢☢
CT myelography cervical spine	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢

Variant: 2 Lumbosacral plexopathy, acute or chronic, nontraumatic. No known malignancy. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
MRI lumbosacral plexus without and with IV contrast	Usually Appropriate	O
MRI lumbosacral plexus without IV contrast	Usually Appropriate	O
MRI lumbar spine without and with IV contrast	May Be Appropriate	O
MRI lumbar spine without IV contrast	May Be Appropriate	O
CT abdomen and pelvis with IV contrast	May Be Appropriate	☢☢☢
MRI lumbar spine with IV contrast	Usually Not Appropriate	O
MRI lumbosacral plexus with IV contrast	Usually Not Appropriate	O
MRI pelvis with IV contrast	Usually Not Appropriate	O
MRI pelvis without and with IV contrast	Usually Not Appropriate	O
MRI pelvis without IV contrast	Usually Not Appropriate	O
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	☢☢☢
CT lumbar spine with IV contrast	Usually Not Appropriate	☢☢☢
CT lumbar spine without IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT lumbar spine without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT myelography lumbar spine	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢

Variant: 3 Brachial plexopathy, traumatic (not perinatal). Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
MRI brachial plexus without IV contrast	Usually Appropriate	O
MRI brachial plexus without and with IV contrast	Usually Appropriate	O
MRI cervical spine without and with IV contrast	May Be Appropriate	O
MRI cervical spine without IV contrast	May Be Appropriate	O
CT cervical spine without IV contrast	May Be Appropriate	☢☢☢
CT myelography cervical spine	May Be Appropriate	☢☢☢☢
US neck	Usually Not Appropriate	O
MRI brachial plexus with IV contrast	Usually Not Appropriate	O
MRI cervical spine with IV contrast	Usually Not Appropriate	O
CT cervical spine with IV contrast	Usually Not Appropriate	☢☢☢
CT cervical spine without and with IV contrast	Usually Not Appropriate	☢☢☢
CT neck with IV contrast	Usually Not Appropriate	☢☢☢
CT neck without and with IV contrast	Usually Not Appropriate	☢☢☢
CT neck without IV contrast	Usually Not Appropriate	☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢

Variant: 4 Lumbosacral plexopathy, traumatic. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
MRI lumbosacral plexus without and with IV contrast	Usually Appropriate	O
MRI lumbosacral plexus without IV contrast	Usually Appropriate	O
MRI lumbar spine without and with IV contrast	May Be Appropriate	O
MRI lumbar spine without IV contrast	May Be Appropriate	O
MRI pelvis without and with IV contrast	May Be Appropriate	O
MRI pelvis without IV contrast	May Be Appropriate	O
CT abdomen and pelvis with IV contrast	May Be Appropriate	☢☢☢
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
CT lumbar spine without IV contrast	May Be Appropriate	☢☢☢
CT myelography lumbar spine	May Be Appropriate	☢☢☢☢
MRI lumbar spine with IV contrast	Usually Not Appropriate	O
MRI lumbosacral plexus with IV contrast	Usually Not Appropriate	O
MRI pelvis with IV contrast	Usually Not Appropriate	O
CT lumbar spine with IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT lumbar spine without and with IV contrast	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢

Variant: 5 Brachial plexopathy, known malignancy or post-treatment syndrome. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
MRI brachial plexus without IV contrast	Usually Appropriate	O
MRI brachial plexus without and with IV contrast	Usually Appropriate	O

MRI cervical spine without and with IV contrast	May Be Appropriate	O
MRI cervical spine without IV contrast	May Be Appropriate	O
CT neck with IV contrast	May Be Appropriate	☢☢☢
CT neck without IV contrast	May Be Appropriate	☢☢☢
FDG-PET/CT whole body	May Be Appropriate	☢☢☢☢
US neck	Usually Not Appropriate	O
MRI brachial plexus with IV contrast	Usually Not Appropriate	O
MRI cervical spine with IV contrast	Usually Not Appropriate	O
CT cervical spine with IV contrast	Usually Not Appropriate	☢☢☢
CT cervical spine without and with IV contrast	Usually Not Appropriate	☢☢☢
CT cervical spine without IV contrast	Usually Not Appropriate	☢☢☢
CT neck without and with IV contrast	Usually Not Appropriate	☢☢☢
CT myelography cervical spine	Usually Not Appropriate	☢☢☢☢

Variant: 6 Lumbosacral plexopathy, known malignancy or post-treatment syndrome. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
MRI lumbosacral plexus without and with IV contrast	Usually Appropriate	O
MRI lumbosacral plexus without IV contrast	Usually Appropriate	O
MRI lumbar spine without and with IV contrast	May Be Appropriate	O
MRI lumbar spine without IV contrast	May Be Appropriate	O
MRI pelvis without and with IV contrast	May Be Appropriate	O
MRI pelvis without IV contrast	May Be Appropriate	O
CT abdomen and pelvis with IV contrast	May Be Appropriate	☢☢☢
FDG-PET/CT whole body	May Be Appropriate	☢☢☢☢
MRI lumbar spine with IV contrast	Usually Not Appropriate	O
MRI lumbosacral plexus with IV contrast	Usually Not Appropriate	O
MRI pelvis with IV contrast	Usually Not Appropriate	O
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	☢☢☢
CT lumbar spine with IV contrast	Usually Not Appropriate	☢☢☢
CT lumbar spine without IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT lumbar spine without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT myelography lumbar spine	Usually Not Appropriate	☢☢☢☢

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Summary of Literature Review

Introduction/Background

Plexopathy refers to abnormal neurological symptoms and signs that localize to an anatomically defined network of nerves called a plexus [1-5]. The following major neural plexuses are considered in this document:

- Brachial plexus: formed from the C5–T1 ventral rami (and occasionally C4 and/or T2), with terminal branches supplying motor and sensory innervation to the upper extremity.
- Lumbosacral plexus: comprised of the lumbar (L1–L4) and sacral (L4–S4) plexuses, which are connected via the lumbosacral trunk (L4–L5). Lumbar plexus terminal branches supply motor and sensory innervation to the obturator and femoral nerve territories including the muscles of the anterior and medial thigh. Sacral plexus terminal branches supply motor and sensory innervation to the gluteal (motor only), peroneal, and tibial nerve territories, including the muscles of the gluteal region, lateral, and posterior thigh and lower leg.

Plexopathy may manifest as neuropathic pain (shoulder and arm, or back and leg), dysesthesia, and/or burning or electric sensation occurring in >1 peripheral nerve distributions. Complete plexopathy causes weakness, sensory loss, and flaccid loss of tendon reflexes in regions innervated by the nerves. The clinical diagnosis of plexopathy is confirmed by electrodiagnostic studies. Plexopathy may be caused by diverse pathologies including trauma, nerve entrapment, neoplasm, inflammatory, infectious, autoimmune, hereditary, or idiopathic etiologies [2-10]. In contradistinction to plexopathy, pain radiating in a dermatomal distribution with or without accompanying sensory loss or motor loss reflecting a spinal nerve root innervation would be considered clinical evidence of radiculopathy. The role of imaging in the setting of radiculopathy is addressed in the ACR Appropriateness Criteria® topic on "Cervical Neck Pain or Cervical Radiculopathy" [11] and the ACR Appropriateness Criteria® topic on "Low Back Pain" [12]. The evaluation of brachial plexopathy due to entrapment is addressed by the ACR Appropriateness Criteria® topic on "Thoracic Outlet Syndrome" [13]. This Appropriateness Criteria is for the evaluation of plexopathy in adults and does not include evaluation of birth-related trauma.

Special Imaging Considerations

This document refers to "MRI of the brachial plexus" or "MRI of the lumbosacral plexus," acknowledging the potential variability of ordering practices across institutions. It is important to note that MRI acquisition for the brachial or lumbosacral plexus differs from sequences that would be in a routine neck, chest, spine, or pelvic MRI. Imaging of the plexus should include orthogonal views through the oblique planes of the plexus, with T1-weighted, T2-weighted, fat-saturated T2-weighted, or short tau inversion recovery sequences, and may also include fat-saturated T1-weighted postcontrast sequences [3-6,9,10,14]. The term "MR Neurography" generally refers to high-resolution T2-weighted sequences of peripheral nerves, and these are routinely performed in a dedicated MRI of the brachial or lumbosacral plexus. Research is ongoing with regards to the optimal MR neurography technique for plexus imaging [15-20]. Research also continues regarding the use and possible advantages of higher field strength [21] in regards to spatial resolution and contrast [4], volumetric sequences [22], and diffusion tensor imaging [6,23-26]. Imaging at 1.5T may be beneficial to reduce artifact if metal is present in the area of clinical concern.

Initial Imaging Definition

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition

defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care)

OR

- There are complementary procedures (ie, more than one procedure is ordered as a set or simultaneously wherein each procedure provides unique clinical information to effectively manage the patient's care).

Discussion of Procedures by Variant

Variant 1: Brachial plexopathy, acute or chronic, nontraumatic. No known malignancy. Initial imaging.

This variant encompasses nontraumatic brachial plexopathy occurring in patients without a history of systemic malignancy or post-treatment syndrome. The differential diagnosis for nontraumatic brachial plexopathy includes inflammatory, infectious, immune-mediated, hereditary, and idiopathic etiologies that tend to affect the plexus diffusely, as well as neoplasms or extrinsic compressive lesions that focally involve the plexus [5,6,9,10,27,28]. The evaluation of brachial plexopathy due to entrapment is addressed by the ACR Appropriateness Criteria® topic on "Thoracic Outlet Syndrome" [13].

Primary tumors of the brachial plexus are most commonly benign peripheral nerve sheath schwannomas and neurofibromas, which can be sporadic or can be associated with neurofibromatosis type 2 and type 1, respectively. Malignant peripheral nerve sheath tumors of the brachial plexus are rare and occur more frequently in patients with neurofibromatosis type 1. The most common non-neurogenic primary tumors of the brachial plexus are desmoid tumors and lipomas [27]. Lymphoma can involve the plexus either because of local encasement or nerve infiltration. Extrinsic tumors can directly invade or metastasize to the brachial plexus [29], most commonly due to lung and breast cancer, respectively. Superior sulcus tumors of the lung (Pancoast tumors) often directly invade the lower trunk of the brachial plexus and can be associated with Horner syndrome and pain along the ulnar nerve distribution. Variant 5 describes brachial plexopathy in the setting of a known malignancy or post-treatment syndrome; however, plexopathy can be the first clinical presentation of neoplastic disease.

Systemic, inflammatory, and/or immune-mediated processes that involve the brachial plexus include Parsonage-Turner syndrome (ie, neuralgic amyotrophy or brachial plexitis) [30-32], chronic inflammatory neuropathies (eg, chronic inflammatory demyelinating polyradiculoneuropathy, multifocal motor neuropathy, Lewis-Sumner syndrome) [15,33-38], hereditary neuropathies (eg, Charcot-Marie-Tooth syndrome) [39], sarcoidosis [27], and infection [40-42]. The diagnosis of these disorders is typically based on clinical and electrodiagnostic evaluation, as the imaging features can overlap considerably.

Variant 1: Brachial plexopathy, acute or chronic, nontraumatic. No known malignancy. Initial imaging.

A. CT Myelography Cervical Spine

There is no relevant literature regarding the use of CT myelography of the cervical spine in the evaluation of nontraumatic brachial plexopathy. Myelography is not routinely performed for the evaluation of nontraumatic plexopathy because it does not directly evaluate the plexus lateral to the neural foramina.

Variant 1: Brachial plexopathy, acute or chronic, nontraumatic. No known malignancy. Initial imaging.
B. CT Neck

There is no relevant literature regarding the use of neck CT in the evaluation of nontraumatic brachial plexopathy. CT offers the next highest level of anatomic visualization of the brachial plexus after MRI and can evaluate for adjacent soft-tissue lesions or tumors that may involve the plexus [43]. CT with IV contrast can be useful for detecting and characterizing soft-tissue masses and tumors, which are in the differential diagnosis of nontraumatic brachial plexopathy and therefore may provide additional information over CT without IV contrast in this setting [43].

Variant 1: Brachial plexopathy, acute or chronic, nontraumatic. No known malignancy. Initial imaging.
C. CT Cervical Spine

There is no relevant literature regarding the use of CT cervical spine in the evaluation of nontraumatic brachial plexopathy. CT cervical spine cannot visualize the preganglionic nerve roots and does not fully evaluate the postganglionic brachial plexus because of the narrow field of view and limited soft-tissue contrast resolution relative to MRI.

Variant 1: Brachial plexopathy, acute or chronic, nontraumatic. No known malignancy. Initial imaging.
D. FDG-PET/CT Whole Body

There is no relevant literature to support the use of fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG)-PET/CT in the evaluation of nontraumatic brachial plexopathy in the absence of a known malignancy.

Variant 1: Brachial plexopathy, acute or chronic, nontraumatic. No known malignancy. Initial imaging.
E. MRI Brachial Plexus

Brachial plexus MRI has been shown to be useful in evaluating nontraumatic brachial plexopathy because of its superior soft-tissue contrast and good spatial resolution, providing detailed definition of intraneural anatomy as well as localizing pathologic lesions in conditions in which electrodiagnostic and physical findings are nonspecific [6,9,10,27]. Tagliafico et al [44] in a blinded, retrospective review studied 157 patients who underwent brachial plexus MRI found an overall sensitivity of 81%, specificity of 91%, positive predictive value of 82%, negative predictive value of 91%, and accuracy of 88% when compared with the reference standard of surgical findings and clinical follow-up. Du et al [45] in a retrospective review studied 191 patients and found that the brachial plexus MRI provided additional information beyond that of clinical evaluation and electrodiagnostic studies in 45% of patients. Hilgenfeld et al [46] in a blinded, retrospective review studied 36 patients and found that brachial plexus MRI could reliably differentiate compressive from noncompressive plexopathy in all patients. MRI with and without IV contrast can be useful for detecting and characterizing several of the etiologies in the differential diagnosis of nontraumatic brachial plexopathy and may provide additional information over MRI without IV contrast in this setting [47].

Variant 1: Brachial plexopathy, acute or chronic, nontraumatic. No known malignancy. Initial imaging.

F. MRI Cervical Spine

Cervical spine MRI is inferior to brachial plexus MRI for the evaluation of nontraumatic brachial plexopathy because it does not directly evaluate the brachial plexus lateral to the neural foramina. However, the clinical diagnosis of plexopathy can be challenging, and it may be unclear whether neurologic signs and symptoms localize to a single nerve root (radiculopathy) or to the brachial plexus (plexopathy) because of considerable overlap in these clinical presentations [48,49]. In cases in which there is clinical uncertainty of whether plexopathy or radiculopathy is present, MRI cervical spine may be complementary and is often performed prior to MRI brachial plexus because of a considerably higher prevalence of radiculopathy-related degenerative spine disease. In these situations, MRI with and without IV contrast usually does not provide significant additional information over MRI without IV contrast. The role of imaging in the setting of radiculopathy is addressed in the ACR Appropriateness Criteria® topic on "Cervical Neck Pain or Cervical Radiculopathy" [11].

Variant 1: Brachial plexopathy, acute or chronic, nontraumatic. No known malignancy. Initial imaging.

G. US Neck

There is no relevant literature to support the use of ultrasound (US) as the primary imaging modality for patients with nontraumatic brachial plexopathy in whom clinical and electrodiagnostic evaluation has been inconclusive. US may be a useful supplemental test in selected centers [50]. US has been described as an adjunctive tool for assessment of nerve enlargement in patients with a clinically diagnosed neuropathy [30,35,39,51-55]. US can be very useful for image-guided therapy, including regional anesthesia, which is beyond the scope of this topic.

Variant 2: Lumbosacral plexopathy, acute or chronic, nontraumatic. No known malignancy. Initial imaging.

This variant encompasses nontraumatic lumbosacral plexopathy occurring in patients without a history of systemic malignancy or post-treatment syndrome. The differential diagnosis for nontraumatic lumbosacral plexopathy includes entrapment, inflammatory, autoimmune, hereditary, ischemic, and idiopathic etiologies that tend to affect the plexus diffusely, as well as neoplasms or extrinsic compressive lesions that focally involve the plexus [2-4,7,8].

Entrapment neuropathies are a common cause of lumbosacral plexopathy and can result from spinal or extraspinal compression [3]. The clinical and electrodiagnostic features of lumbosacral plexopathy and radiculopathy often overlap, and imaging can help localize the site of nerve compression [1]. In some cases, lumbosacral plexus MRI can detect spinal causes of nerve root compression that may not be detected on a lumbar spine MRI, such as a lateral disc herniation that compresses the distal nerve root lateral to the neural foramen [3]. Lumbosacral plexus MRI may also detect signal abnormalities in the nerve root and plexus distal to the site of spinal neural compression, which may provide additional evidence of the symptomatic nerve root compression level [56]. A commonly described cause of extraspinal nerve entrapment is the piriformis syndrome, in which the sciatic nerve can be compressed by the piriformis muscle due to either the anatomic variation or an associated fibrous band [7,8,57]. Imaging can be useful for detecting nerve abnormalities and/or neuromuscular variants associated with extraspinal nerve compression and can help guide treatment with surgery, interventional, or noninvasive therapy.

Primary tumors of the lumbosacral plexus are most commonly benign peripheral nerve sheath schwannomas and neurofibromas, which can be sporadic or can be associated with neurofibromatosis. Malignant peripheral nerve sheath tumors of the lumbosacral plexus are rare and occur more frequently in patients with neurofibromatosis [7]. Other primary malignant or metastatic tumors can also involve the lumbosacral plexus [4]. Variant 6 describes lumbosacral plexopathy in the setting of a known malignancy or post-treatment syndrome; however, plexopathy can be the first clinical presentation of neoplastic disease. Non-neoplastic masses involving the lumbosacral plexus can include hematoma, abscess, aneurysm, amyloidosis [4], and endometriosis [58].

Systemic, inflammatory, and/or immune-mediated processes that involve the lumbosacral plexus include diabetic amyotrophy [7], acute inflammatory demyelinating polyneuropathy (Guillain-Barré syndrome) [8], chronic inflammatory demyelinating polyneuropathy [33,38,59,60], ischemic nerve injury, hereditary neuropathies (eg, Charcot-Marie-Tooth disease), sarcoidosis [4], infection (eg, zoster-associated limb paresis) [40-42], and idiopathic [4]. The diagnosis of these is typically based on clinical and electrodiagnostic evaluation, as the imaging features can overlap considerably.

Variant 2: Lumbosacral plexopathy, acute or chronic, nontraumatic. No known malignancy. Initial imaging.
A. CT Myelography Lumbar Spine

There is no relevant literature to support the use of CT myelography of the lumbar spine in the evaluation of nontraumatic lumbosacral plexopathy. Myelography is not routinely performed for the evaluation of nontraumatic plexopathy as it does not evaluate the plexus lateral to the neural foramina.

Variant 2: Lumbosacral plexopathy, acute or chronic, nontraumatic. No known malignancy. Initial imaging.
B. CT Abdomen and Pelvis

There is no relevant literature to support the use of abdominal and pelvic CT in the evaluation of nontraumatic lumbosacral plexopathy. CT offers the next highest level of anatomic visualization of the lumbosacral plexus after MRI, and can evaluate for adjacent soft-tissue lesions or tumors that may involve the plexus. CT with IV contrast can be useful for detecting and characterizing soft-tissue masses and tumors, which are in the differential diagnosis of nontraumatic lumbosacral plexopathy and therefore may provide additional information over CT without IV contrast in this setting.

Variant 2: Lumbosacral plexopathy, acute or chronic, nontraumatic. No known malignancy. Initial imaging.
C. CT Lumbar Spine

There is no relevant literature regarding the use of CT lumbar spine in the evaluation of nontraumatic lumbosacral plexopathy. CT lumbar spine cannot visualize the preganglionic nerve roots and does not fully evaluate the postganglionic lumbosacral plexus because of its narrow field of view and limited soft-tissue contrast resolution relative to MRI.

Variant 2: Lumbosacral plexopathy, acute or chronic, nontraumatic. No known malignancy. Initial imaging.
D. FDG-PET/CT Whole Body

There is no relevant literature to support the use of FDG-PET/CT in the evaluation of nontraumatic lumbosacral plexopathy in the absence of a known malignancy.

Variant 2: Lumbosacral plexopathy, acute or chronic, nontraumatic. No known malignancy. Initial imaging.

E. MRI Lumbar Spine

Lumbar spine MRI is inferior to lumbosacral plexus MRI for the evaluation of nontraumatic lumbosacral plexopathy because it does not directly evaluate the lumbosacral plexus lateral to the neural foramina. However, the clinical diagnosis of plexopathy can be challenging and it may be unclear whether neurologic signs and symptoms localize to a single nerve root (radiculopathy) or to the lumbosacral plexus (plexopathy) because of the considerable overlap in these clinical presentations [1]. In cases in which there is clinical uncertainty whether plexopathy or radiculopathy is present, MRI lumbar spine may be complementary and is often performed prior to MRI lumbosacral plexus because of a considerably higher prevalence of radiculopathy-related degenerative spine disease. In these situations, MRI with and without IV contrast usually does not provide significant additional information over MRI without IV contrast. The role of imaging in the setting of radiculopathy is addressed in the ACR Appropriateness Criteria® topic on "Low Back Pain" [12].

Variant 2: Lumbosacral plexopathy, acute or chronic, nontraumatic. No known malignancy. Initial imaging.

F. MRI Lumbosacral Plexus

Lumbosacral plexus MRI is useful in evaluating nontraumatic lumbosacral plexopathy because of its superior soft-tissue contrast and good spatial resolution, providing good definition of intraneural anatomy as well as localizing pathologic lesions in conditions where electrodiagnostic and physical findings are nonspecific [1-4,7,8,61]. The clinical diagnosis of plexopathy can be challenging, and it may be unclear whether neurologic signs and symptoms localize to a single nerve root (radiculopathy) or to the lumbosacral plexus (plexopathy) because of the considerable overlap in these clinical presentations [1]. For this reason, literature evaluating the diagnostic performance of lumbosacral plexus MRI often includes patients who present with radiculopathy as well as plexopathy. Dessouky et al [62], in a retrospective review, analyzed 202 patients who received MRI of lumbosacral plexus for the evaluation of radiculopathy (57%), pelvic pain (28%), or groin pain (15%) and found that 71% of patients had a change in management resulting from MRI findings. Zhang et al [63] in a retrospective review of 137 patients who received MRI lumbosacral plexus with diffusion-weighted neurography for a clinical diagnosis of sciatica found either nerve root compression or abnormal intraneural signal in the nerves in all patients. Chazen et al [56] in a retrospective review of 64 patients with radiculopathy symptoms who underwent lumbosacral plexus MRI and electromyography found abnormal intraneural signal in 45% of lumbosacral plexus MRI examinations and a statistically significant correlation between nerve signal abnormality on MRI and findings of active radiculopathy on electromyography. Petrasic et al [64] in retrospective review of 23 patients presenting with chronic pelvic pain and/or dysfunction and clinically suspected chronic cauda equina syndrome who underwent MRI lumbosacral plexus found that 78% of patients had a change in diagnosis and 81% had a change in management from the MRI findings. MRI with and without IV contrast can be useful for detecting and characterizing several of the etiologies in the differential diagnosis of nontraumatic lumbosacral plexopathy and may provide additional information over MRI without IV contrast in this setting.

Variant 2: Lumbosacral plexopathy, acute or chronic, nontraumatic. No known malignancy. Initial imaging.

G. MRI Pelvis

There is no relevant literature to support the use of MRI of the pelvis (without dedicated plexus

imaging) in the evaluation of nontraumatic lumbosacral plexopathy.

Variant 3: Brachial plexopathy, traumatic (not perinatal). Initial imaging.

This variant encompasses initial imaging of post-traumatic brachial plexopathy in adults, and does not apply to birth-related injury of the brachial plexus. Evaluation of the patient with trauma and suspected spinal cord or proximal nerve root injury is addressed in the ACR Appropriateness Criteria® topic on "Suspected Spine Trauma" [65]. Traumatic brachial plexopathy can occur after blunt force injury, such as from a fall, sports-related injury, or motor vehicle collision (particularly motorcycle accident), or can result from penetrating injury, such as from a gunshot wound [5,66]. Penetrating and open injuries to the brachial plexus are often managed with early surgical exploration, whereas blunt and closed injuries may be managed nonoperatively or surgically, depending on the location and severity of the injury [67]. Imaging of the brachial plexus in the acute post-traumatic setting can be challenging because subarachnoid hemorrhage may obscure nerve roots and soft-tissue edema may obscure the brachial plexus itself. Therefore imaging to determine extent of plexus injury should ideally be delayed until approximately 1 month following the trauma, as it can take 3 to 4 weeks for a pseudomeningocele to develop and for blood and regional soft-tissue edema to resolve [28,68]. In closed injuries, it is important to determine if the nerve is completely ruptured, as this often necessitates early operative management and has a worse prognosis, or is stretched but remains intact [67]. It is also important to determine whether a brachial plexus injury is preganglionic (involving intraspinal nerve roots) or postganglionic (involving plexus lateral to the dorsal root ganglion) because the prognosis and reconstruction approaches are different [66]. Imaging provides significant value in differentiating these possibilities, which are often not able to be reliably determined on the basis of clinical and electrodiagnostic evaluation. In addition to directly visualizing a nerve root avulsion, imaging may detect associated findings, such as pseudomeningocele, spinal cord edema or hemorrhage, edema, fibrosis, or neuroma [69]. Imaging can also detect injuries to nearby structures, such as soft-tissue hematoma or displaced fracture, which may result in extrinsic compression of the brachial plexus.

Variant 3: Brachial plexopathy, traumatic (not perinatal). Initial imaging.
A. CT Myelography Cervical Spine

CT myelography provides high-resolution imaging capable of detecting traumatic cervical nerve root avulsions and pseudomeningocele formation and can evaluate for other spinal traumatic injuries, such as fracture, hematoma, or cerebrospinal fluid leak [70]. However, CT myelography can only evaluate for preganglionic nerve root injury and does not directly visualize the postganglionic brachial plexus. Therefore, MRI brachial plexus is preferred over CT myelography cervical spine as the first-line imaging test to evaluate for postganglionic brachial plexus injury. CT myelography performed to assess for cervical nerve root avulsion injury should be ideally delayed until approximately 1 month after the initial trauma to allow time for resolution of hemorrhage and formation of a pseudomeningocele [28,68].

Variant 3: Brachial plexopathy, traumatic (not perinatal). Initial imaging.
B. CT Cervical Spine

There is no relevant literature to support the use of CT cervical spine in the evaluation of traumatic brachial plexopathy. CT cervical spine cannot visualize the preganglionic nerve roots and does not fully evaluate the postganglionic brachial plexus due to a narrow field of view and limited soft-tissue contrast resolution relative to MRI. However, CT cervical spine may be complementary in the evaluation of associated traumatic osseous injuries to the vertebrae or clavicle that could compress the brachial plexus or nerve roots. The role of imaging in the setting of suspected cervical spine

trauma is addressed in the ACR Appropriateness Criteria® topic on "Suspected Spine Trauma" [65]. CT cervical spine with IV contrast usually does not provide significant additional information over CT cervical spine without IV contrast in the evaluation of traumatic brachial plexopathy.

Variant 3: Brachial plexopathy, traumatic (not perinatal). Initial imaging.
C. CT Neck

There is no relevant literature to support the use of CT neck in the evaluation of traumatic brachial plexopathy. CT offers the next highest level of visualization of soft-tissue injuries to the brachial plexus after MRI and can evaluate for accompanying traumatic osseous injury. The role of imaging in the setting of suspected cervical spine trauma is addressed in the ACR Appropriateness Criteria® topic on "Suspected Spine Trauma" [65]. CT with IV contrast may better delineate adjacent vascular anatomy, and thus the predicted course of the major neuronal elements, but otherwise does not provide significant additional information over CT without IV contrast in the evaluation of traumatic brachial plexopathy.

Variant 3: Brachial plexopathy, traumatic (not perinatal). Initial imaging.
D. FDG-PET/CT Whole Body

There is no relevant literature to support the use of FDG-PET/CT in the evaluation of traumatic brachial plexopathy.

Variant 3: Brachial plexopathy, traumatic (not perinatal). Initial imaging.
E. MRI Brachial Plexus

Brachial plexus MRI is considered superior to CT in the evaluation of traumatic brachial plexopathy because of its inherently better soft-tissue contrast and good spatial resolution [6,9,10,27]. MRI can identify traumatic nerve root avulsions, which are crucial to detect in order to plan surgical reconstruction and determine prognosis [66]. Wade et al [71] studied 29 consecutive patients requiring brachial plexus exploration following trauma and found that brachial plexus MRI had a diagnostic accuracy of 79% for detecting C5 to T1 nerve root avulsion and that pseudomeningocele as a surrogate marker for root avulsion had a diagnostic accuracy of 68%. MRI can also directly assess the postganglionic brachial plexus and can confirm whether nerve integrity is maintained, differentiating minor stretching injuries from complete nerve disruptions [66]. Tagliafico et al [44], in a blinded retrospective review, studied 38 patients who received brachial plexus MRI for traumatic plexopathy and found a sensitivity of 84%, specificity 91%, positive predictive value of 91%, negative predictive value of 83%, and accuracy of 87% when compared to the reference standard of surgical findings and clinical follow-up. Fuzari et al [69] performed a systematic review of 3 articles reporting diagnostic accuracy of MRI for traumatic brachial plexus injury and found that the studies lacked methodological rigor, thus concluding that more rigorous research should be conducted in this area. Research is ongoing into new MRI sequences that might improve evaluation of traumatic brachial plexopathy, but these are not routinely performed outside of a research setting. For example, diffusion tensor imaging and tractography have been under investigation and show promise in the evaluation of nerve injury and disruption of nerve microstructure [69].

Brachial plexus MRI can also delineate other post-traumatic complications that may contribute to symptoms of plexopathy, such as regional soft-tissue hematoma, traumatic neuromas, and scarring. In the post-treatment setting following surgical nerve repair, brachial plexus MRI can be used to study the repaired nerve, assess for complications, and assess for secondary signs of neuropathy, such as degenerative muscular atrophy [72]. MRI with IV contrast usually does not

provide significant additional information over MRI without IV contrast for the initial imaging of traumatic brachial plexopathy, though the addition of contrast can help differentiate between vascular structures and nerves.

Variant 3: Brachial plexopathy, traumatic (not perinatal). Initial imaging.
F. MRI Cervical Spine

There is no relevant literature to support the use of MRI of the cervical spine (without dedicated plexus imaging) in the evaluation of traumatic brachial plexopathy. However, MRI of the cervical spine is often complementary to MRI of the brachial plexus in the setting of traumatic brachial plexopathy. In particular, cervical spine MRI is better suited to detect findings of preganglionic injury, such as nerve root avulsion and pseudomeningocele, than brachial plexus MRI, which is generally focused on the postganglionic plexus lateral to the neural foramina. Cervical spine MRI would also be able to assess for intraspinal hemorrhage or other traumatic spinal injuries that could be associated with a nerve root avulsion. The role of imaging in the setting of suspected cervical spine trauma is addressed in the ACR Appropriateness Criteria® topic on "Suspected Spine Trauma" [65]. MRI with and without IV contrast usually does not provide significant additional information over MRI without IV contrast for the initial imaging of traumatic brachial plexopathy.

Variant 3: Brachial plexopathy, traumatic (not perinatal). Initial imaging.
G. US Neck

US neck is typically not the first-line imaging test for evaluation of traumatic brachial plexopathy and is generally not useful as the primary imaging modality in this clinical scenario. Researchers have investigated whether US might be useful as a supplemental test for traumatic brachial plexopathy [73]. US cannot visualize the intraspinal (preganglionic) portions of the nerve roots medial to the neural foramen but can detect indirect findings of nerve root avulsion, such as empty neural foramina, paravertebral pseudomeningocele, retracted proximal stumps, or neuromas [73]. Chin et al [67] performed a systematic review of 7 articles that studied the diagnostic performance of US for suspected traumatic brachial plexus injury in 133 patients compared to the reference standard of surgical findings. They found that sensitivity was higher for the injuries of the upper and middle (C5–C7) spinal nerves than for the lower (C8 and T1) spinal nerves, with pooled sensitivities of 93% for C5, 94% for C6, 95% for C7, 71% for C8, and 56% for T1. Zhu et al [73] found that all C5 to C7 nerve roots were able to be visualized by US, but only 92% of C8 and 51% of T1 nerve roots were able to be visualized.

Variant 4: Lumbosacral plexopathy, traumatic. Initial imaging.

This variant encompasses initial imaging of lumbosacral plexopathy occurring in the post-traumatic setting. Relative to the brachial plexus, traumatic injuries to the lumbosacral plexus are less common because of the supportive strength of the bony pelvis, which helps to prevent direct injury [3,4,7]. Traumatic injury to the lumbosacral plexus can occur after high-speed blunt injury and is often associated with pelvic or hip fractures and dislocations or lumbar spinal fractures [2]. Injuries are most commonly stretching injuries or nerve compression from an adjacent hematoma or fracture and less commonly complete nerve avulsion or rupture [2]. It is important to detect nerve discontinuity or root avulsion because these findings may necessitate surgical intervention [4]. Imaging of the lumbosacral plexus in the acute post-traumatic setting can be challenging, as hemorrhage may obscure nerve roots and soft-tissue edema may obscure the lumbosacral plexus. Therefore, imaging to determine extent of plexus injury should ideally be delayed until approximately one month after trauma, as it can take 3 to 4 weeks for a pseudomeningocele to develop and for blood and regional soft-tissue edema to resolve. Because traumatic injuries to the

lumbosacral plexus often occur in the setting of major, life-threatening trauma, the imaging evaluation may include many studies that are outside of the scope of this document. The role of imaging in the setting of major blunt trauma is addressed in the ACR Appropriateness Criteria® topic on "Major Blunt Trauma" [74]. The role of imaging in the setting of penetrating trauma to the lower abdomen and pelvis is addressed in the ACR Appropriateness Criteria® topic on "Penetrating Trauma-Lower Abdomen and Pelvis" [75].

Another cause of indirect traumatic injury to the lumbosacral plexus is avulsion fractures at muscular attachment sites, which can cause traumatic edema, hematoma, or inflammation that compresses the adjacent nerve [8]. This can be seen with avulsions of the hamstrings at the ischial tuberosity (injuring sciatic or pudendal nerve), adductor muscles at the inferior pubic symphysis (injuring obturator nerve), or gluteal muscles at the greater trochanter (injuring superior or inferior gluteal nerves) [8]. Similar to avulsion fractures, tendinopathy of the major muscular attachments can also result in local soft-tissue swelling and inflammation that can involve adjacent nerves [3,8]. Iatrogenic injury to the lumbosacral plexus or terminal branches can also occur after childbirth or surgery, such as total hip arthroplasty, gynecologic, or genitourinary surgery [2].

Variant 4: Lumbosacral plexopathy, traumatic. Initial imaging.
A. CT Myelography Lumbar Spine

CT myelography provides high-resolution imaging of the thecal sac capable of detecting traumatic nerve root avulsion or pseudomeningocele. However, CT myelography can only evaluate for preganglionic nerve root injury and does not directly visualize the postganglionic lumbosacral plexus. Therefore, MRI lumbosacral plexus is superior to CT myelography lumbar spine in the evaluation of postganglionic lumbosacral plexus injury. CT myelography performed to assess for preganglionic lumbosacral nerve root injury should be ideally delayed until approximately 1 month after the initial trauma to allow time for resolution of hemorrhage and formation of a pseudomeningocele.

Variant 4: Lumbosacral plexopathy, traumatic. Initial imaging.
B. CT Abdomen and Pelvis

There is no relevant literature to support the use of CT abdomen and pelvis in the evaluation of traumatic lumbosacral plexopathy. However, this test is often used in the setting of major blunt trauma (in which lumbosacral plexus injuries are most common), and can detect many of the associated findings such as pelvic fractures or hematomas. The role of imaging in the setting of major blunt trauma is addressed in the ACR Appropriateness Criteria® topic on "Major Blunt Trauma" [74]. CT abdomen and pelvis with IV contrast usually does not provide significant additional information relevant to the evaluation of traumatic lumbosacral plexopathy compared with CT without IV contrast.

Variant 4: Lumbosacral plexopathy, traumatic. Initial imaging.
C. CT Lumbar Spine

There is no relevant literature to support the use of CT lumbar spine in the evaluation of traumatic lumbosacral plexopathy. CT lumbar spine (without myelographic contrast) cannot visualize the preganglionic nerve roots and does not fully evaluate the postganglionic lumbosacral plexus because of its narrow field of view. However, CT lumbar spine may be complementary because lumbosacral plexus injuries often occur in association with severe lumbar spinal and pelvic fractures and dislocations. The role of imaging in the setting of suspected lumbar spine trauma is addressed in the ACR Appropriateness Criteria® topic on "Suspected Spine Trauma" [65]. The role

of imaging in the setting of major blunt trauma is addressed in the ACR Appropriateness Criteria® topic on "Major Blunt Trauma" [74]. The role of imaging in the setting of penetrating trauma to the lower abdomen and pelvis is addressed in the ACR Appropriateness Criteria® topic on "Penetrating Trauma–Lower Abdomen and Pelvis" [75]. CT lumbar spine with IV contrast usually does not provide significant additional information over CT lumbar spine without IV contrast in the evaluation of traumatic lumbosacral plexopathy.

Variant 4: Lumbosacral plexopathy, traumatic. Initial imaging.
D. FDG-PET/CT Whole Body

There is no relevant literature to support the use of FDG-PET/CT in the evaluation of traumatic lumbosacral plexopathy.

Variant 4: Lumbosacral plexopathy, traumatic. Initial imaging.
E. MRI Lumbar Spine

There is no relevant literature to support the use of lumbar spine MRI (without dedicated plexus imaging) in the evaluation of traumatic lumbosacral plexopathy. However, lumbar spine MRI may be complementary to lumbosacral plexus MRI in the setting of traumatic lumbosacral plexopathy. In particular, lumbar spine MRI may be better suited to detect findings of preganglionic injury, such as nerve root avulsion and pseudomeningocele, than lumbosacral plexus MRI, which is generally focused on the postganglionic plexus lateral to the dorsal root ganglion. Lumbar spine MRI may also be able to assess for intraspinal hemorrhage or other traumatic spinal injuries that could be associated with a nerve root avulsion. The role of imaging in the setting of suspected lumbar spine trauma is addressed in the ACR Appropriateness Criteria® topic on "Suspected Spine Trauma" [65]. MRI with and without IV contrast usually does not provide significant additional information over MRI without IV contrast for the initial imaging of traumatic lumbosacral plexopathy.

Variant 4: Lumbosacral plexopathy, traumatic. Initial imaging.
F. MRI Lumbosacral Plexus

Lumbosacral plexus MRI has been shown to be superior to CT in the evaluation of traumatic lumbosacral plexopathy because of its inherently better soft-tissue contrast and good spatial resolution. MRI can directly assess the postganglionic lumbosacral plexus and can confirm whether nerve integrity is maintained, differentiating minor stretching injuries from complete nerve disruptions [4]. Lumbosacral plexus MRI can also delineate other post-traumatic complications that may contribute to symptoms of plexopathy, such as regional soft-tissue hematoma, edema, inflammation, avulsion fracture, tendinopathy, traumatic neuromas, and scarring [8]. MRI to assess the extent of injury should be ideally delayed until approximately 1 month after the initial trauma to allow time for resolution of hemorrhage and edema that can obscure the lumbosacral plexus acutely. MRI with and without IV contrast usually does not provide significant additional information over MRI without IV contrast for the initial imaging of acute traumatic lumbosacral plexopathy, though the addition of contrast can help differentiate between vascular structures and nerves.

Variant 4: Lumbosacral plexopathy, traumatic. Initial imaging.
G. MRI Pelvis

There is no relevant literature to support the use of MRI of the pelvis (without dedicated plexus imaging) in the evaluation of traumatic lumbosacral plexopathy. There is considerable overlap in anatomic coverage of an MRI pelvis and a dedicated MRI lumbosacral plexus; however, the latter is

optimized for nerve imaging and is therefore superior in the evaluation of traumatic lumbosacral plexopathy. An MRI pelvis may be useful for evaluating adjacent pelvic soft-tissue injuries and hematomas that may occur in association with lumbosacral plexus injury. The role of imaging in the setting of major blunt trauma is addressed in the ACR Appropriateness Criteria® topic on "Major Blunt Trauma" [74]. The role of imaging in the setting of penetrating trauma to the lower abdomen and pelvis is addressed in the ACR Appropriateness Criteria® topic on "Penetrating Trauma–Lower Abdomen and Pelvis" [75]. MRI pelvis with and without IV contrast usually does not provide significant additional information over MRI pelvis without IV contrast in the evaluation of traumatic lumbosacral plexopathy.

Variant 5: Brachial plexopathy, known malignancy or post-treatment syndrome. Initial imaging.

This variant encompasses brachial plexopathy occurring in the setting of a known malignancy or a post-treatment syndrome occurring months to years after radiation treatment for a regional malignancy.

Malignant involvement of the brachial plexus can occur by extrinsic compression, direct invasion, perineural tumor spread, or distant metastases [29]. Malignant peripheral nerve sheath tumors of the brachial plexus are rare and occur more frequently in patients with neurofibromatosis. Extrinsic tumors can directly invade or metastasize to the brachial plexus [29], most commonly from cancers of the lung or breast, respectively. Superior sulcus tumors of the lung (Pancoast tumors) often directly invade the lower trunk of the brachial plexus and can be associated with Horner syndrome. Cervical, supraclavicular, or axillary lymph node metastases can involve the brachial plexus through extrinsic compression or extranodal tumor infiltration. Bone metastases to the cervical and upper thoracic spine are common and frequently demonstrate extraosseous extension of tumor into the neural foramina and/or epidural space, which can compress the brachial plexus nerve roots. Lymphoma can involve the plexus, either via local encasement or nerve infiltration [76]. Imaging is important to characterize the type and extent of malignant involvement of the brachial plexus and can aid in treatment planning. The role of imaging in the setting of breast cancer is addressed in the ACR Appropriateness Criteria® topic on "Monitoring Response to Neoadjuvant Systemic Therapy for Breast Cancer" [77]. The role of imaging in the setting of lung cancer is addressed in the ACR Appropriateness Criteria® topic on "Noninvasive Clinical Staging of Primary Lung Cancer" [78].

In addition, patients can develop brachial plexopathy in the months to years after radiation treatment for regional malignancy, which could be due to recurrent tumor or postradiation injury. Imaging can be helpful in differentiating radiation plexopathy from recurrent malignancy [20,79-81], for which management differs significantly.

Variant 5: Brachial plexopathy, known malignancy or post-treatment syndrome. Initial imaging.

A. CT Myelography Cervical Spine

There is no relevant literature to support the use of CT myelography for evaluation of brachial plexopathy in the setting of known malignancy or post-treatment syndrome. CT myelography provides high-resolution imaging of the thecal sac capable of detecting thecal sac compression or intradural masses; however, it does not directly visualize the postganglionic brachial plexus.

Variant 5: Brachial plexopathy, known malignancy or post-treatment syndrome. Initial imaging.

B. CT Neck

CT neck offers the next highest level of anatomic visualization and can assess for masses or lymphadenopathy in the neck, supraclavicular fossa, or axilla that involve the brachial plexus [43]. CT can also provide complementary information to MRI in the setting of malignant tumor invasion of the brachial plexus (eg, Pancoast tumor) as it can better delineate lytic bone destruction or fractures of the vertebrae and ribs and better evaluates the lung apex. CT with IV contrast can provide additional information over CT without IV contrast for evaluation of malignancy or post-treatment syndrome, as it can improve delineation of tumor margins and/or fibrosis [43]. The role of imaging in the setting of breast cancer is addressed in the ACR Appropriateness Criteria® topic on "Monitoring Response to Neoadjuvant Systemic Therapy for Breast Cancer" [77]. The role of imaging in the setting of lung cancer is addressed in the ACR Appropriateness Criteria® topic on "Noninvasive Clinical Staging of Primary Lung Cancer" [78].

Variant 5: Brachial plexopathy, known malignancy or post-treatment syndrome. Initial imaging.

C. CT Cervical Spine

There is no relevant literature regarding the use of CT cervical spine in the evaluation of brachial plexopathy in the setting of known malignancy or post-treatment syndrome. CT cervical spine cannot visualize the preganglionic nerve roots and does not fully evaluate the postganglionic brachial plexus because of its narrow field of view and limited soft-tissue contrast resolution relative to MRI.

Variant 5: Brachial plexopathy, known malignancy or post-treatment syndrome. Initial imaging.

D. FDG-PET/CT Whole Body

FDG-PET/CT can identify the extent of tumor involvement in the setting of malignancy. FDG-PET/CT can be used to evaluate for regional malignant tumor involvement of the plexus and can aid in the detection of perineural tumor spread or lymphoma infiltration of the plexus [76]. FDG-PET/CT can also be used in the post-treatment setting to differentiate radiation plexopathy from neoplastic plexopathy [82]. However, low FDG uptake does not exclude malignant involvement of the brachial plexus. The role of imaging in the setting of breast cancer is addressed in the ACR Appropriateness Criteria® topic on "Monitoring Response to Neoadjuvant Systemic Therapy for Breast Cancer" [77]. The role of imaging in the setting of lung cancer is addressed in the ACR Appropriateness Criteria® topic on "Noninvasive Clinical Staging of Primary Lung Cancer" [78].

Variant 5: Brachial plexopathy, known malignancy or post-treatment syndrome. Initial imaging.

E. MRI Brachial Plexus

Brachial plexus is considered an optimal imaging modality to evaluate brachial plexopathy in the setting of known malignancy or post-treatment syndrome because of its superior soft-tissue contrast and good spatial resolution [6,9,10,27]. Extrinsic compression, direct tumor invasion, or metastasis to the brachial plexus can be demonstrated on MRI brachial plexus. Perineural tumor spread or lymphoma infiltrating the plexus [76] can also be visualized on MRI. In the post-treatment setting, MRI can help differentiate radiation plexopathy from neoplastic plexopathy [20,79,80]. Research is ongoing into new MRI sequences that might improve evaluation of neoplastic brachial plexopathy, but these are not routinely performed outside of a research setting. For example, Yuh et al [20] in a retrospective review of 23 patients who underwent brachial plexus MRI with diffusion-weighted imaging for evaluation of a mass-like or infiltrative lesion found that

apparent diffusion coefficient values were significantly different between malignant tumors and postradiation changes or benign tumors. MRI with and without IV contrast can provide additional information over MRI without IV contrast in the setting of malignancy or post-treatment syndromes, as it can improve delineation of tumor margins and/or fibrosis [5,6,9,10,27].

Variant 5: Brachial plexopathy, known malignancy or post-treatment syndrome. Initial imaging.

F. MRI Cervical Spine

There is no relevant literature to support the use of MRI of the cervical spine (without dedicated plexus imaging) for evaluation of brachial plexopathy in the setting of known malignancy or post-treatment syndrome. However, MRI cervical spine may be complementary in this clinical scenario because it can better assess for cervical spinal metastases with extraosseous extension of tumor into the neural foramina and epidural space that can compress the brachial plexus nerve roots or spinal cord. In the post-treatment setting, radiation injury or tumor recurrence involving the intradural nerve roots would also be better evaluated with cervical spine MRI. MRI with and without IV contrast can provide additional information over MRI without IV contrast in the setting of malignancy or post-treatment syndromes, as it can improve delineation of tumor margins and/or fibrosis.

Variant 5: Brachial plexopathy, known malignancy or post-treatment syndrome. Initial imaging.

G. US Neck

US neck is typically not the first-line imaging test for evaluation of brachial plexopathy in the setting of a known malignancy or post-treatment syndrome, and is generally not useful as the primary imaging modality in this clinical scenario. Researchers have investigated whether US might be useful as a supplemental test to evaluate malignant involvement or radiation-induced plexopathy of the brachial plexus [50,83]. Kultur et al [81] in a prospective analysis of 23 patients receiving radiation therapy for breast cancer found statistically significant differences between the ipsilateral and contralateral brachial plexus on shear wave elastography; however, this technique is not routinely used outside of research settings.

Variant 6: Lumbosacral plexopathy, known malignancy or post-treatment syndrome. Initial imaging.

This variant encompasses lumbosacral plexopathy occurring in the setting of a known malignancy or a post-treatment syndrome occurring months to years after radiation treatment for a regional malignancy.

Oncology patients may present with plexopathy at the time of initial diagnosis. Malignancy can involve the lumbosacral plexus by extrinsic compression, direct invasion, perineural tumor spread [84,85], or distant metastasis [29]. Malignant peripheral nerve sheath tumors of the lumbosacral plexus are rare and occur more frequently in patients with neurofibromatosis [7]. Primary tumors of the pelvis (eg, colon, cervix, ovary, urinary bladder, or prostate), retroperitoneum, or pelvic bones can compress or directly invade the plexus [29]. Lymph node metastases in the retroperitoneum or pelvis can involve the lumbosacral plexus through extrinsic compression or extranodal tumor infiltration. Bone metastases to the lumbosacral spine are common and frequently demonstrate extraosseous extension of tumor into the neural foramina and/or epidural space, which can compress multiple lumbosacral nerve roots. Metastases directly to the lumbosacral plexus can also occur, most commonly from cancers of the breast and lung [29]. Lymphoma can involve the plexus

either due to local encasement or nerve infiltration [76]. Imaging is important to characterize the type and extent of malignant involvement of the lumbosacral plexus and can aid in treatment planning. The role of imaging in the setting of colorectal cancer is addressed in the ACR Appropriateness Criteria® topic on "Pretreatment Staging of Colorectal Cancer" [86]. The role of imaging in the setting of prostate cancer is addressed in the ACR Appropriateness Criteria® topics on "Prostate Cancer–Pretreatment Detection, Surveillance, and Staging" [87] and "Post-treatment Follow-up of Prostate Cancer" [88]. The role of imaging in the setting of bladder cancer is addressed in the ACR Appropriateness Criteria® topics on "Pretreatment Staging of Muscle-Invasive Bladder Cancer" [89] and "Post-Treatment Surveillance of Bladder Cancer" [90]. The role of imaging in the setting of endometrial cancer is addressed in the ACR Appropriateness Criteria® topic on "Pretreatment Evaluation and Follow-Up of Endometrial Cancer" [91]. The role of imaging in the setting of cervical cancer is addressed in the ACR Appropriateness Criteria® topic on "Pretreatment Planning of Invasive Cancer of the Cervix" [92]. The role of imaging in the setting of ovarian cancer is addressed in the ACR Appropriateness Criteria® topic on "Staging and Follow-up of Ovarian Cancer" [93].

In addition, patients can develop lumbosacral plexopathy in the months to years after radiation treatment for regional malignancy, which could be due to recurrent tumor or postradiation injury. Imaging can be helpful in differentiating radiation plexopathy from recurrent malignancy [20], for which management differs significantly.

Variant 6: Lumbosacral plexopathy, known malignancy or post-treatment syndrome. Initial imaging.

A. CT Myelography Lumbar Spine

There is no relevant literature to support the use of CT myelography for evaluation of lumbosacral plexopathy in the setting of known malignancy or post-treatment syndrome. CT myelography provides high-resolution imaging of the thecal sac capable of detecting thecal sac compression or intradural masses; however, it does not directly visualize the postganglionic lumbosacral plexus.

Variant 6: Lumbosacral plexopathy, known malignancy or post-treatment syndrome. Initial imaging.

B. CT Abdomen and Pelvis

CT offers the next highest level of anatomic visualization of the lumbosacral plexus after MRI and can assess for pelvic masses or lymphadenopathy that involve the plexus. CT with IV contrast can provide additional information over CT without IV contrast for evaluation of malignancy or post-treatment syndromes, as it can improve delineation of tumor margins and/or fibrosis. The role of imaging in the setting of colorectal cancer is addressed in the ACR Appropriateness Criteria® topic on "Pretreatment Staging of Colorectal Cancer" [86]. The role of imaging in the setting of prostate cancer is addressed in the ACR Appropriateness Criteria® topics on "Prostate Cancer–Pretreatment Detection, Surveillance, and Staging" [87] and "Post-treatment Follow-up of Prostate Cancer" [88]. The role of imaging in the setting of bladder cancer is addressed in the ACR Appropriateness Criteria® topics on "Pretreatment Staging of Muscle-Invasive Bladder Cancer" [89] and "Post-Treatment Surveillance of Bladder Cancer" [90]. The role of imaging in the setting of endometrial cancer is addressed in the ACR Appropriateness Criteria® topic on "Pretreatment Evaluation and Follow-Up of Endometrial Cancer" [91]. The role of imaging in the setting of cervical cancer is addressed in the ACR Appropriateness Criteria® topic on "Pretreatment Planning of Invasive Cancer of the Cervix" [92]. The role of imaging in the setting of ovarian cancer is addressed in the ACR Appropriateness Criteria® topic on "Staging and Follow-up of Ovarian Cancer" [93].

Variant 6: Lumbosacral plexopathy, known malignancy or post-treatment syndrome. Initial imaging.
C. CT Lumbar Spine

There is no relevant literature regarding the use of CT lumbar spine in the evaluation of lumbosacral plexopathy in the setting of known malignancy or post-treatment syndrome. CT lumbar spine cannot visualize the preganglionic nerve roots and does not fully evaluate the postganglionic lumbosacral plexus because of its narrow field of view and limited soft-tissue contrast resolution relative to MRI.

Variant 6: Lumbosacral plexopathy, known malignancy or post-treatment syndrome. Initial imaging.
D. FDG-PET/CT Whole Body

FDG-PET/CT can identify the extent of tumor involvement in the setting of malignancy but has relatively poor resolution for the lumbosacral plexus compared with MRI. FDG-PET/CT can be used to evaluate for pelvic tumors or metastases that involve the plexus and can aid in the detection of perineural tumor spread of pelvic malignancies [84] or lymphoma infiltration of the plexus [76]. However, low FDG uptake does not exclude malignant involvement of the lumbosacral plexus. The role of imaging in the setting of colorectal cancer is addressed in the ACR Appropriateness Criteria® topic on "Pretreatment Staging of Colorectal Cancer" [86]. The role of imaging in the setting of prostate cancer is addressed in the ACR Appropriateness Criteria® topics on "Prostate Cancer–Pretreatment Detection, Surveillance, and Staging" [87] and "Post-treatment Follow-up of Prostate Cancer" [88]. The role of imaging in the setting of bladder cancer is addressed in the ACR Appropriateness Criteria® topics on "Pretreatment Staging of Muscle-Invasive Bladder Cancer" [89] and "Post-Treatment Surveillance of Bladder Cancer" [90]. The role of imaging in the setting of endometrial cancer is addressed in the ACR Appropriateness Criteria® topic on "Pretreatment Evaluation and Follow-Up of Endometrial Cancer" [91]. The role of imaging in the setting of cervical cancer is addressed in the ACR Appropriateness Criteria® topic on "Pretreatment Planning of Invasive Cancer of the Cervix" [92]. The role of imaging in the setting of ovarian cancer is addressed in the ACR Appropriateness Criteria® topic on "Staging and Follow-up of Ovarian Cancer" [93].

Variant 6: Lumbosacral plexopathy, known malignancy or post-treatment syndrome. Initial imaging.
E. MRI Lumbar Spine

There is no relevant literature to support the use of MRI of the lumbar spine (without dedicated plexus imaging) for evaluation of lumbosacral plexopathy in the setting of known malignancy or post-treatment syndrome. However, lumbar spine MRI may be complementary in this clinical scenario because it can better assess for lumbosacral spinal metastases with extraosseous extension of tumor into the neural foramina and epidural space that can compress the lumbosacral plexus nerve roots [3,7]. In the post-treatment setting, radiation injury or tumor recurrence involving the intradural nerve roots would also be better evaluated with lumbar spine MRI. MRI with and without IV contrast can provide additional information over MRI without IV contrast in the setting of malignancy or post-treatment syndromes, as it can improve delineation of tumor margins and/or fibrosis.

Variant 6: Lumbosacral plexopathy, known malignancy or post-treatment syndrome. Initial imaging.
F. MRI Lumbosacral Plexus

Lumbosacral plexus MRI is considered an optimal imaging modality to evaluate lumbosacral plexopathy in the setting of known malignancy or post-treatment syndrome because of its superior soft-tissue contrast and good spatial resolution [2-4,7,8]. Extrinsic compression or tumor infiltration of the lumbosacral plexus can be well demonstrated on lumbosacral plexus MRI. Perineural tumor spread along the lumbosacral plexus [84,85] or lymphoma infiltrating the plexus [76] can also be visualized on MRI. MRI with and without IV contrast can provide additional information over MRI without IV contrast in the setting of malignancy or post-treatment syndromes, as it can improve delineation of tumor margins and/or fibrosis.

Variant 6: Lumbosacral plexopathy, known malignancy or post-treatment syndrome. Initial imaging.

G. MRI Pelvis

There is no relevant literature to support the use of MRI of the pelvis (without dedicated plexus imaging) for evaluation of lumbosacral plexopathy in the setting of known malignancy or post-treatment syndrome. There is considerable overlap in anatomic coverage of an MRI pelvis and a dedicated MRI lumbosacral plexus; however, the latter is optimized for nerve imaging and is therefore superior in the evaluation of lumbosacral plexopathy. An MRI of the pelvis may be complementary to dedicated MRI of lumbosacral plexus in cases of primary pelvic malignancies that can involve the lumbosacral plexus. The role of imaging in the setting of colorectal cancer is addressed in the ACR Appropriateness Criteria® topic on "Pretreatment Staging of Colorectal Cancer" [86]. The role of imaging in the setting of prostate cancer is addressed in the ACR Appropriateness Criteria® topics on "Prostate Cancer–Pretreatment Detection, Surveillance, and Staging" [87] and "Post-treatment Follow-up of Prostate Cancer" [88]. The role of imaging in the setting of bladder cancer is addressed in the ACR Appropriateness Criteria® topics on "Pretreatment Staging of Muscle-Invasive Bladder Cancer" [89] and "Post-Treatment Surveillance of Bladder Cancer" [90]. The role of imaging in the setting of endometrial cancer is addressed in the ACR Appropriateness Criteria® topic on "Pretreatment Evaluation and Follow-Up of Endometrial Cancer" [91]. The role of imaging in the setting of cervical cancer is addressed in the ACR Appropriateness Criteria® topic on "Pretreatment Planning of Invasive Cancer of the Cervix" [92]. The role of imaging in the setting of ovarian cancer is addressed in the ACR Appropriateness Criteria® topic on "Staging and Follow-up of Ovarian Cancer" [93]. MRI with and without IV contrast can provide additional information over MRI without IV contrast in the setting of malignancy or post-treatment syndromes, as it can improve delineation of tumor margins and/or fibrosis.

Summary of Highlights

- **Variant 1**: MRI brachial plexus without IV contrast or MRI brachial plexus without and with IV contrast is usually appropriate as the initial imaging of patients with acute, chronic, or nontraumatic brachial plexopathy and no known malignancy. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).
- **Variant 2**: MRI lumbosacral plexus without and with IV contrast or MRI lumbosacral plexus without IV contrast is usually appropriate as the initial imaging of patients with acute, chronic, or nontraumatic lumbosacral plexopathy and no known malignancy. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).

- **Variant 3**: MRI brachial plexus without IV contrast or MRI brachial plexus without and with IV contrast is usually appropriate as the initial imaging of patients with traumatic (not perinatal) brachial plexopathy.
- These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).
- **Variant 4**: MRI lumbosacral plexus without and with IV contrast or MRI lumbosacral plexus without IV contrast is usually appropriate as the initial imaging of patients with traumatic lumbosacral plexopathy.
- These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).
- **Variant 5**: MRI brachial plexus without IV contrast or MRI brachial plexus without and with IV contrast is usually appropriate as the initial imaging of patients with brachial plexopathy in the setting of known malignancy or post-treatment syndrome. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).
- **Variant 6**: MRI lumbosacral plexus without and with IV contrast or MRI lumbosacral plexus without IV contrast is usually appropriate as the initial imaging of patients with lumbosacral plexopathy in the setting of known malignancy or post-treatment syndrome. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents, please go to the ACR website at https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a

		rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as “Varies.”

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