



CLINICAL GUIDELINES

Peripheral Nerve Disorders (PND) Imaging Guidelines

Version 1.1

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eviCore healthcare Clinical Decision Support Tool Diagnostic Strategies: This tool addresses common symptoms and symptom complexes. Imaging requests for individuals with atypical symptoms or clinical presentations that are not specifically addressed will require physician review. Consultation with the referring physician, specialist and/or individual's Primary Care Physician (PCP) may provide additional insight.

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Peripheral Nerve Disorders (PND) Imaging Guidelines

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Abbreviations for Peripheral Nerve Disorders Imaging Guidelines

AIDS	Acquired Immunodeficiency Syndrome
ALS	Amyotrophic Lateral Sclerosis
CIDP	Chronic Inflammatory Demyelinating Polyneuropathy
CNS	central nervous system
CPK	creatinine phosphokinase
CT	computed tomography
EMG	electromyogram
LEMS	Lambert-Eaton Myasthenic Syndrome
MG	myasthenia gravis
MRI	magnetic resonance imaging
MRN	magnetic resonance neurography
MRS	magnetic resonance spectroscopy
NCV	nerve conduction velocity
PET	positron emission tomography
PNS	peripheral nervous system
PNST	Peripheral Nerve Sheath Tumor
POEMS	Polyneuropathy, Organomegaly, Endocrinopathy, M-protein, Skin changes
TOS	Thoracic Outlet Syndrome

PN-1: General Guidelines

PN-1.0: General Guidelines

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PN-1.0: General Guidelines

A current clinical evaluation (within 60 days) is required before advanced imaging can be considered. The clinical evaluation may include a relevant history and physical examination, including a neurological examination, appropriate laboratory studies, non-advanced imaging modalities, electromyography and nerve conduction (EMG/NCV) studies. Other meaningful contact (telephone call, electronic mail or messaging) by an established patient can substitute for a face-to-face clinical evaluation.

If imaging of peripheral nerves is indicated, ultrasound is the preferred modality for superficial peripheral nerves. MRI may be used for imaging deep nerves such as the lumbosacral plexus or nerves obscured by overlying bone such as the brachial plexus or for surgical planning. CT is limited to cases in which MRI is contraindicated.

References

1. Bowen BC, Maravilla KR, Saraf-Lavi. Magnetic Resonance Imaging of the Peripheral Nervous System. In Latchaw RE, Kucharczyk J, Moseley ME. *Imaging of the Nervous System. Diagnostic and Therapeutic Applications*. Vol 2, Mosby, Philadelphia, 2005, pp.1479-1497.
2. Walker WO. Ultrasonography in peripheral nervous system diagnosis. *Continuum*. 2017 Oct; 23 (5, Peripheral Nerve and Motor Neuron Disorders):1276-1294.
3. Ohana M, Moser T, Moussaoui A, et al. Current and future imaging of the peripheral nervous system. *Diagnostic and Interventional Imaging*. 2014; 95 (1):17-26.
4. Stoll G, Bendszus M, Perez J, et al. Magnetic resonance imaging of the peripheral nervous system. *J Neurol*. 2009 Jul; 256(7):1043-51.
5. Stoll G, Wilder-Smith E, and Bendszus M. Imaging of the peripheral nervous system. *Handb Clin Neurol*. 2013; 115: 137-153.
6. Kim S, Choi J-Y, Huh Y-M, et al. Role of magnetic resonance imaging in entrapment and compressive neuropathy—what, where, and how to see the peripheral nerves on the musculoskeletal magnetic resonance image: part 1. Overview and lower extremity. *Eur Radiol*. 2007 Jan; 17(1):139-149.
7. Russell JA. General Approach to Peripheral Nerve Disorders. *CONTINUUM: Lifelong Learning in Neurology*. 2017;23(5):1241-1262. doi:10.1212/con.0000000000000519.

PN-2: Focal Neuropathy		
Focal Disorder	EMG/NCV Initially?	Advanced Imaging
Carpal Tunnel Syndrome	YES	<ul style="list-style-type: none"> ➤ Ultrasound Wrist or MRI Wrist without contrast (CPT® 73321) to estimate size of the carpal tunnel and diameter of the median nerve may be helpful in the evaluation and confirmation of carpal tunnel syndrome pre-operatively when EMG findings are equivocal and clinical findings are uncertain. ➤ See MS-21: Wrist in the Musculoskeletal Imaging Guidelines and SP-3: Neck (Cervical Spine) Pain Without/With Neurological Features (Including Stenosis) and Trauma in the Spine Imaging Guidelines.
Ulnar Neuropathy	YES	Ultrasound for evaluation when clinical findings and EMG/NCV findings are uncertain. MRI Elbow without contrast (CPT® 73221) or MRI Upper Arm or Forearm without contrast (CPT® 73218) for complex cases when diagnosis remains uncertain after EMG and US or for pre-op planning.
Radial Neuropathy	YES	<ul style="list-style-type: none"> ➤ MRI Upper Arm or Forearm without contrast (CPT® 73218) in severe cases when surgery is being considered. ➤ MRI Upper Arm or Forearm without and with contrast (CPT® 73220) if there is a suspicion of a nerve tumor such as a neuroma.
<p>Radial Neuropathy Notes: Leads to wrist drop with common sites of entrapment the inferior aspect of the humerus (Saturday night palsy) or the forearm (Posterior Interosseus Syndrome). Trauma or fractures of the humerus, radius, or ulna can damage the radial nerve.</p>		
Sciatic Neuropathy	YES	MRI Pelvis without contrast (CPT® 72195) may be performed in the evaluation of these entities. CT Pelvis without contrast is not indicated due to lack of soft tissue contrast. It should only be performed in the rare circumstance of contrast allergy and contraindication to MRI such as pacemaking device.
<p>Sciatic Neuropathy Notes: Trauma to the gluteal area with hematoma, injection palsy, hip or pelvic fractures, or hip replacement (arthroplasty) and rarely Piriformis Syndrome involves entrapment of the sciatic nerve at the sciatic notch in the pelvis by a tight piriformis muscle band.</p>		
Femoral Neuropathy	NO	MRI Pelvis without contrast (CPT® 72195) may be performed in the evaluation of these entities.

Focal Disorder	EMG/NCV Initially?	Advanced Imaging
Femoral Neuropathy Notes: May occur as a complication of pelvic surgery in women or those on anticoagulants with retroperitoneal bleeding, or as a mononeuropathy in diabetics		
Meralgia Paresthetica	NO	MRI Pelvis without contrast (CPT® 72195) may be performed in cases of diagnostic uncertainty or for pre-op planning. CT Pelvis without contrast is not indicated due to lack of soft tissue contrast. It should only be performed in the rare circumstance of contrast allergy and contraindication to MRI such as pacemaking device.
Meralgia Paresthetica Notes: Sensory loss in the lateral femoral cutaneous nerve as it exits the pelvis under the inguinal ligament (lateral thigh without extension into lower leg), and is usually easily diagnosed based on a careful history and physical exam. EMG/NCV testing is often technically difficult and not required.		
Peroneal Neuropathy	YES	MRI Knee without contrast (CPT® 73721) or MRI Lower Extremity other than joint without contrast (CPT® 73718) in severe cases when surgery is considered.
Tarsal Tunnel Syndrome	N/A	See MS-27: Foot (Tarsal Tunnel Syndrome) in the Musculoskeletal Imaging Guidelines.

References

1. Andreisek G, Crook DW, Burg D, et al. Peripheral neuropathies of the median, radial, and ulnar nerves: MR imaging features. *RadioGraphics*. 2006 Sep-Oct; 26 (5):1267-1287.
2. Iverson DJ. MRI detection of cysts of the knee causing common peroneal neuropathy. *Neurology*. 2005 Dec 13; 65(11):1829-1831.
3. Cartwright MS, Walker FO. Neuromuscular ultrasound in common entrapment neuropathies. *Muscle & Nerve*. 2013 Sep 2; 48(5):696-704.
4. Linda DD, Harish S, Stewart BG, et al. Multimodality imaging of peripheral neuropathies of the upper limb and brachial plexus. *RadioGraphics*. 2010 Sep; 30(5):1373-1400.
5. Hobson-Webb LD and Juel VC. Common Entrapment Neuropathies. *Continuum*. 2017 Apr; 23 (2):487-511.
6. Tsivgoulis G and Alexandrov AV. Ultrasound in neurology. *Continuum*. 2016 Oct; 22(5, Neuroimaging):1655-1677.

PN-3: Polyneuropathy			
Poly-Disorder	EMG/NCV Initially?	Advanced Imaging	Comments
PNS/CNS Crossover Syndromes	YES	MRI Brain and/or Spinal Cord without and with contrast if clinical findings point to abnormalities in those areas.	Guillain-Barré syndrome
AIDS Related Cytomegaloviral Neuropathy/ Radiculopathy	YES	MRI Lumbar Spine without and with contrast (CPT® 72158) if suspected.	Urinary retention and a clinically confusing picture in the legs.
Chronic Inflammatory Demyelinating Polyneuropathy (CIDP)	YES	MRI Lumbar Spine without and with contrast (CPT® 72158) if uncertain following EMG.	
Multifocal Motor Neuropathy	YES	MRI Brachial Plexus without and with contrast (CPT® 71552 or CPT® 73220) if uncertain following EMG.	
POEMS (Polyneuropathy, Organomegaly, Endocrinopathy, M-protein, Skin changes)	YES	Advanced imaging is for the non-neurological entities of this rare osteosclerotic plasmacytoma syndrome.	See ONC-25: Multiple Myeloma and Plasmacytomas in the Oncology Imaging Guidelines.
Subacute Sensory Neuronopathy & Other Paraneoplastic Demyelinating Neuropathies	YES	Advanced imaging should be guided by specific clinical concern (See relevant guideline). For evaluation of suspected paraneoplastic syndromes: See ONC-30.3: Paraneoplastic Syndromes in the Oncology Imaging Guidelines	

References

- Anders HJ, Goebel FD. Cytomegalovirus polyradiculopathy in patients with AIDS. *Clin Infect Dis*. 1998 Aug 27; 27 (2):345-352.
- Duggins AJ, McLoed JG, Pollard JD, et al. Spinal root and plexus hypertrophy in chronic inflammatory demyelinating polyneuropathy. *Brain*. 1999 July 1; 122(7):1383-1390.
- Amato AA, Barohn RJ, Katz JS, et al. Clinical spectrum of chronic acquired demyelinating polyneuropathies. *Muscle & Nerve*. 2001 Mar; 24(3):311-324.
- Darnell RB, Posner JB. Paraneoplastic Syndromes Involving the Nervous System. *N Engl J Med*. 2003; 349:1543-1554.
- Antoine JC, Bouhour F, Camdessanche JP. [18F] fluorodeoxyglucose positron emission tomography in the diagnosis of cancer in patients with paraneoplastic neurological syndrome and anti-Hu antibodies. *Ann Neurol*. 2000 July; 48(1):105-108.

PN-4: Brachial Plexus

- Brachial plexus studies can be coded either as MRI Upper Extremity other than joint without or without and with contrast (CPT® 73218 or CPT® 73220), MRI Chest without or without and with contrast (CPT® 71550 or CPT® 71552) or MRI Neck without or without and with contrast (CPT® 70540 or CPT® 70543) (if upper trunk) after EMG/NCV examination for:
 - ◆ Malignant infiltration (EMG not required)
 - ◆ Radiation plexitis to rule out malignant infiltration
 - ◆ Brachial plexitis (Parsonage-Turner Syndrome or painful brachial amyotrophy).
 - Self-limited syndrome characterized by initial shoulder region pain followed by weakness of specific muscles in a pattern which does not conform to involvement of a single root or distal peripheral nerve
 - Consider MRI Cervical Spine if radiculopathy.
 - See **SP-3: Neck (Cervical Spine) Pain Without/With Neurological Features (Including Stenosis) and Trauma** in the Spine Imaging Guidelines
 - ◆ Traumatic injury
 - ◆ Neurogenic Thoracic Outlet Syndrome (TOS) failed a 2 to 3 month trial of conservative management and are being considered for surgical treatment.
 - ◆ See **CH-31: Thoracic Outlet Syndrome (TOS)** in the Chest Imaging Guidelines
 - ◆ Preoperative study which requires evaluation of the brachial plexus

References

1. Adkins MC, Wittenberg KH. MR imaging of nontraumatic brachial plexopathies: frequency and spectrum of findings. *RadioGraphics*. 2000 July; 20 (4):1023-1032.
2. Bykowski J, Aulino JM, Berger KL, et al. (2016). ACR Appropriateness Criteria® Plexopathy. *American College of Radiology (ACR)*.
3. Van Es HW. MRI of the brachial plexus. *Eur Radiol*. 2001 Jan; 11(2):325-336.
4. Foley KM, Kori SH, Posner JB. Brachial plexus lesions in patients with cancer: 100 cases. *Neurology*. 1981 Jan; 31 (1):45-50.
5. Cascino TL, Harper CM, Thomas JE, et al. Distinction between neoplastic and radiation-induced brachial plexopathy, with emphasis on the role of EMG. *Neurology*. 1989 April; 39(4):502-506.
6. Husband JE, MacVicar AD, Padhani AR, et al. Symptomatic brachial plexopathy following treatment for breast cancer: Utility of MR imaging with surface-coil techniques. *Radiology*. 2000 March; 214 (3):837-842.
7. McDonald TJ, Miller JD, Pruitt S. Acute brachial plexus neuritis: an uncommon cause of shoulder pain. *Am Fam Physician*. 2000 Nov 1; 62 (9):2067-2072.

PN-5: Lumbar and Lumbosacral Plexus

- The following studies can be considered: MRI Pelvis without and with contrast with fat suppression imaging (CPT® 72197) **OR** MRI Abdomen and Pelvis without and with contrast with fat suppression imaging (CPT® 74183 and CPT® 72197) **OR** if MRI is not available, CT Pelvis with contrast (CPT® 72193) **OR** CT Abdomen and Pelvis with contrast (CPT® 74177) can be considered after EMG/NCV based on whether the upper lumbar plexus (abdominal retroperitoneal space) or the lumbosacral plexus (pelvis), respectively, is involved based on:
- ◆ Malignant infiltration (EMG not required)
 - ◆ Radiation plexopathy to rule out malignant infiltration
 - ◆ Traumatic injury

References

1. Brejt N, Berry J, Nisbet A, et al. Pelvic radiculopathies, lumbosacral plexopathies, and neuropathies in oncologic disease: A multidisciplinary approach to a diagnostic challenge. *Cancer Imaging*. 2013 Dec 30; 13 (4):591-601.
2. McDonald JW, Sadwosky C. Spinal-cord injury. *The Lancet*. 2002 Feb 2; 359 (9304):417-425.

PN-6: Muscle Disorders

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PN-6.1: Neuromuscular Disease

- Myasthenia Gravis (MG) is associated with thymic disease and can undergo:
 - ◆ CT Chest with contrast (CPT® 71260) after an established diagnosis of MG.
 - Can be repeated if initial CT previously negative and now symptoms of chest mass, rising anti-striated muscle antibody titers, or need for preoperative evaluation (clinical presentation, electro-diagnostic studies, and antibody titers).
 - ◆ CT Chest without contrast (CPT® 71250) may be used if there is concern regarding adverse effects of contrast in patients with MG.
- Lambert–Eaton myasthenic syndrome (LEMS) is associated with small cell lung cancer and can undergo:
 - ◆ CT Chest with contrast (CPT® 71260) with a suspected diagnosis (Chest x-ray, symptoms of lung mass, clinical presentation, electro-diagnostic studies, and antibody titers).
 - Can be repeated if initial CT previously negative after 3 months with persistent suspicion.
- Stiff man syndrome is associated with small cell lung cancer and breast cancer
 - ◆ CT Chest with contrast (CPT® 71260) if Stiff Man Syndrome is suspected based on clinical findings.

PN-6.2: Inflammatory Muscle Diseases

- MRI and ultrasound are increasingly being used in the evaluation of muscle disease. MRI may be helpful in demonstrating abnormalities in muscles that are difficult to examine or not clinically weak, and MRI can also help distinguish between different types of muscle disease. MRI is also useful in determining sites for muscle biopsy.
- MRI Lower Extremity other than joint without contrast (CPT® 73718) or MRI Lower Extremity other than joint without and with contrast (CPT® 73720) and/or MRI Upper Extremity other than joint without contrast (CPT® 73218) or MRI Upper Extremity other than joint without and with contrast (CPT® 73220), usually the most affected muscle is imaged (when criteria is met imaging can be approved for bilateral studies) for:
 - ◆ Additional evaluation of myopathy or myositis (based on clinical exam and adjunct testing with EMG/NCV and labs)
 - ◆ To plan muscle biopsy
 - ◆ See **PEDMS-10.3: Inflammatory Muscle Diseases** in the Pediatric Musculoskeletal Imaging Guidelines
- All cases with dermatomyositis and polymyositis can undergo search for occult neoplasm See **ONC-30.3: Paraneoplastic Syndromes** in the Oncology Imaging Guidelines

PN-6.3: Gaucher Disease (Storage Disorders)

- See **AB-11: Gaucher Disease and Hemochromatosis** in the Abdomen Imaging Guidelines.
- See **PEDPN-4: Gaucher Disease** in the Pediatric Peripheral Nerve Disorders Imaging Guidelines.

References

1. Darnell R, Posner J. Paraneoplastic syndromes involving the nervous system. *N Engl J Med*. 2003 Oct; 349:1543-1554.
2. Schweitzer M, Fort J. Cost-effectiveness of MR imaging in evaluating polymyositis. *Am J Roentgenol*. 1995; 165:1469-1471.
3. Adams E, Chow C, Premkumar A, Plotz P. The idiopathic inflammatory myopathies: spectrum of MR imaging findings. *RadioGraphics*. 1995; 15(3):563-574.
4. Park J, Olsen N. Utility of magnetic resonance imaging in the evaluation of patients with inflammatory myopathies. *Curr Rheumatol Reports*. 2001 Aug; 3 (4):334-345.
5. Sekul E, Chow C, Dalakas M. Magnetic resonance imaging of the forearm as a diagnostic aid in patients with sporadic inclusion body myositis. *Neurolog*. 1997 April;48(4):863-866.
6. Lundberg I, Chung Y. Treatment and investigation of idiopathic inflammatory myopathies. *Rheumatology*. 2000 Jan; 39(1):7-17.
7. Park J, Olsen N. Utility of magnetic resonance imaging in the evaluation of patients with inflammatory myopathies. *Curr Rheumatol Reports*. 2001 Aug; 3(4):334-345.
8. Hill C, Zhang Y, Sigurgeirsson B, et al. Frequency of specific cancer types in dermatomyositis and polymyositis: a population-based study. *Lancet*. 2001 Jan 13; 357(9250):96-100.
9. Maas M, Poll L, Terk M. Imaging and quantifying skeletal involvement in Gaucher disease. *B J Radiol*. 2002; 75 suppl 1:A13-A24.
10. Giraldo P, Pocovi M, Perez-Calvo J, et al. Report of the Spanish Gaucher's disease registry: clinical and genetic characteristics. *Haematologica*. 2000 Jan; 85:792-799. 2016.
11. Rosow et al. The Role of Electrodiagnostic Testing, Imaging, and Muscle Biopsy in the Investigation of Muscle Disease. *Continuum*. 2016 Dec; 22(6):1787-1802.
12. Somashekar DK, Davenport MS, Cohan RH, et al. Effect of intravenous low-osmolality iodinated contrast media on patients with myasthenia gravis. *Radiology*. 2013 Jun; 267(3):727-734.

PN-7: Magnetic Resonance Neurography (MRN)

- MRN is currently considered investigational by most payers.
- Use limited to evaluation of complicated cases and diagnostic uncertainty when other studies (EMG/NCV, ultrasound) are equivocal or non-diagnostic and results will determine intervention and/or surgical planning for peripheral nerve surgery and repair

Reference

1. Noguero TM, Barousse R, Cabrera MG, Socolovsky M, Bencardino JT, Luna A. Functional MR Neurography in Evaluation of Peripheral Nerve Trauma and Postsurgical Assessment. *RadioGraphics*. 2019;39(2):427-446. doi:10.1148/rg.2019180112.

PN-8: Amyotrophic Lateral Sclerosis (ALS)

- MRI Brain, Cervical, Thoracic, and Lumbar Spine most often without contrast, but may be without and with contrast with meningeal symptoms.
 - ◆ Can be considered when ALS is suspected (combination of upper and lower motor neuron findings) to establish a diagnosis.
 - ◆ Repeat imaging can be evaluated based on the appropriate **Spine Imaging Guidelines**.

References

1. Agosta F, Chio A, Cosottini M, et al. The present and the future of neuroimaging in amyotrophic lateral sclerosis. *Am J Neuroradiol*. 2010 Nov; 31(10):1769-1777.
2. Kollewe K, Korner S, Dengler R, et al. Magnetic resonance imaging in amyotrophic lateral sclerosis. *Neurology Research International*. 2012; v2012.
3. Filippi M, Agosta F, Abrahams S, et al. EFNS guidelines on the use of neuroimaging in the management of motor neuron diseases. *Eur J Neurol*. 2010 Apr; 17(4):526-e20.
4. Wang S, Melhem ER, Poptani H, et al. Neuroimaging in amyotrophic lateral sclerosis. *Neurotherapeutics*. 2011 Jan; 8 (1):63-71.

PN-9: Peripheral Nerve Sheath Tumors (PNST)

- Tumors (Schwannomas or Neurofibromas) that arise from Schwann cells or other connective tissue of the nerve are located anywhere in the body and can undergo advanced imaging when suspected, which may include:
 - ◆ MRI Brain without and with contrast (CPT® 70553). (Vestibular Schwannomas See **HD-33.1: Acoustic Neuroma and Other Cerebellopontine Angle Tumors** in the Head Imaging Guidelines)
 - ◆ MRI Cervical, Thoracic, and Lumbar Spine without and with contrast (CPT® 72156, CPT® 72157, and CPT® 72158) if paraspinal neurofibroma is found any spine level or multiple simplex perineural neurofibromas.
 - ◆ Follow-up imaging is not needed unless:
 - New symptoms or neurological findings develop
 - Post operatively, at the discretion of the surgeon and to reestablish baseline if the tumor was not completely removed
 - Malignant transformation (5%) is known or suspected; includes a metastatic work-up with CT Chest and Abdomen with contrast (CPT® 71260 and CPT® 74160).
- See **PEDONC-2.3: Neurofibromatosis 1 and 2 (NF1 and NF2)** in the Pediatric Oncology Imaging Guidelines

References

1. Riccardi V. The genetic predisposition to and histogenesis of neurofibromas and neurofibrosarcoma in neurofibromatosis type 1. *Neurosurg Focus*. 2007 Jun 15; 22 (6):E3.
2. Li C, Huang G, Wu H, et al. Differentiation of soft tissue benign and malignant peripheral nerve sheath tumors with magnetic resonance imaging. *Clin Imaging*. 2008 Mar-Apr; 32 (2):121-127.
3. Murovic J, Kim D, Kline D. Neurofibromatosis-associated nerve sheath tumors. Case report and review of the literature. *Neurosurg Focus*. 2006 Jan; 20 (1):1-10.

PN-10: Nuclear Imaging

- Nuclear Medicine
 - ◆ Nuclear medicine studies are not generally indicated in the evaluation of peripheral nerve disorders. See **PEDPN-2: Neurofibromatosis** in the Pediatric Peripheral Nerve Disorders Imaging Guidelines for specific imaging guidelines regarding PET/CT in evaluation of peripheral nerve tumors.