Clinical Policy Bulletin: Magnetic Resonance Neurography

Number: 0387

Policy

Aetna considers magnetic resonance neurography experimental and investigational because the medical literature on the application of this technology in clinical situations remains in early stages of development.

Background

Currently, diagnosis and management of nerve injury due to compression or trauma are generally undertaken without images of the nerves themselves. Although nerves can sometimes be seen in standard magnetic resonance imaging (MRI), the method is so unreliable that nerve images have never played a significant role in diagnosis and clinical usefulness. Magnetic resonance neurography is a new MRI technology requiring special software and hardware upgrades, which are not widely available; currently, this test is only available at a very limited number of medical centers.

Magnetic resonance neurography is capable of generating high resolution longitudinal and cross-sectional images of major peripheral nerves, and has been studied to supplement diagnostic evaluations by electromyography (EMG) and nerve conduction studies in patients with suspected peripheral nerve tumors, traumatic injury, post-irradiation neuritis, chronic compression, and pain syndromes where an anatomic lesion is suspected. Although current evidence supports MR neurography as a promising technique, the outcome data that would determine the efficacy of this technology is limited to studies involving a small number of patients, making it premature to offer conclusions regarding its effectiveness for the general population. Additionally, large-scale, well-conducted, controlled studies with this approach are warranted to determine its efficacy in imaging neurofibromas and distinguishing benign from malignant lesions.

In a prospective observational study of patients with sciatica, Zhang and colleagues (2009) investigated the effectiveness of three-dimensional (3-D) high-spatial resolution diffusion-weighted MR neurography based on steady state free precession (3-D diffusion-weighted steady-state free precession [DW-SSFP]) in the diagnosis of sciatica. The 3-D DW-SSFP sequence was performed on 137 patients with sciatica and 32 patients in control group. The post-processing techniques were used to generate images of lumbo-sacral plexus and sciatic nerve, and the images acquired were assessed based on the presence or absence of nerve abnormality. The certainty of identifying the lumbo-sacral plexus and main branches from all cases was determined in each of the reconstruction planes for each case individually and assessed by using a 3-score scale. The sciatic nerve and its main branches were differentiated and a clear picture was obtained in all subjects. Compared with the control group,
the presence of nerve root compression or increased T2 signal intensity changes can be observed in all patients. The mean score of certainty of identifying the sciatic nerve and main branches was 1.76 +/- 0.4, which indicates that the sciatic nerve and main branches can be identified with certainty. The authors concluded that the 3-D DW-SSFp MR neurography with high spatial and sufficient contrast is an excellent technique to define the nature of sciatica and assists in prognostication and possibly in management.

Du et al (2010) analyzed the role of MR neurography in the evaluation of spinal and peripheral nerve lesions. Imaging studies, medical records, and EMG/nerve conduction studies (NCS) results were analyzed retrospectively in a consecutive series of 191 patients who underwent MR neurography for spinal and peripheral nerve disorders; 91 (47.6 %) of these patients also underwent EMG/NCS studies. In those who underwent both MR neurography and EMG/NCS, MR neurography provided the same or additional diagnostic information in 32 % and 45 % of patients, respectively. Magnetic resonance neurograms were obtained at a median of 12 months after the onset of symptoms. The utility of MR neurography correlated with the interval between the onset of symptoms to MR neurography. Twelve patients underwent repeated MR neurography for serial evaluation. The decrease in abnormal signal detected on subsequent MR neurography correlated with time from onset of symptoms and the time interval between MR neurography, but not with resolution of symptoms. Twenty-one patients underwent MR neurography post-operatively to assess persistent, recurrent, or new symptoms; of these 3 (14.3 %) required a subsequent surgery. The authors concluded that MR neurography is a valuable adjunct to conventional MRI and EMG/NCS in the evaluation and localization of nerve root, brachial plexus, and peripheral nerve lesions. They found that MR neurography is indicated in patients: (i) in whom EMG and traditional MR imaging are inconclusive; (ii) who present with brachial plexopathy who have previously received radiation therapy to the brachial plexus region; (iii) who present with brachial plexopathy and have systemic tumors; and (iv) in patients under consideration for surgery for peripheral nerve lesions or after trauma. The authors also noted that MR neurography is limited by the size of the nerve trunk imaged and the timing of the study.

In a review on new approaches in imaging of the brachial plexus, Vargas et al (2010) stated that imaging plays an essential role for the detection and analysis of pathologic conditions of the brachial plexus. Currently, several new techniques are used in addition to conventional 2-D MR sequences to study the brachial plexus: the 3-D STIR SPACE sequence, 3-D heavily T2w MR myelography sequences (balanced SSFP=CISS 3-D, True FISP 3-D, bFFE and FIESTA), and the diffusion-weighted (DW) neurography sequence with fiber tracking reconstruction (tractography). The 3-D STIR sequence offers complete anatomical coverage of the brachial plexus and the ability to slice through the volume helps to analyze fiber course modification and structure alteration. It allows precise assessment of distortion, compression and interruption of post-ganglionic nerve fibers thanks to the capability of performing maximum intensity projections (MIP) and multi-planar reconstructions (MPRs). The CISS 3D, b-SSFp sequences allow good visualization of nerve roots within the spinal canal and may be used for MR myelography in traumatic plexus injuries. The DW neurography sequence with tractography is still a work in progress, able to demonstrate nerves tracts, their structure alteration or deformation due to pathologic processes surrounding or located along the post-ganglionic brachial plexus. It may become a precious tool for the understanding of the underlying molecular pathophysiologic mechanisms in diseases affecting the brachial plexus and may play a role for surgical planning procedures in the near future.

Eguchi et al (2011) stated that DW imaging (DWI) can provide valuable structural information that may be useful for evaluating pathological changes of the lumbar nerve root. Diffusion-weighted MR neurography has recently been introduced as an alternative way to visualize nerves, but to date, quantitative DWI and MR neurography have not been applied to evaluate the pathology of lumbar nerve roots. These researchers visualized lumbar nerve roots and analyzed their morphology by MR neurography, and measured the apparent diffusion coefficient (ADC) of lumbar nerve roots compressed by herniated disks using 1.5-T MR imaging. A total of 10 consecutive patients (median age of 48.0 and range of 20 to 72 years) with mono-radicular symptoms caused by a lumbar herniated disk and 14 healthy volunteers were studied. Regions of interests (ROIs) were placed on the lumbar
roots at dorsal root ganglia (DRG) and distal spinal nerves on DWI to quantify mean ADC values. The spinal nerve roots were also visualized by MR neurography. In the patients, mean ADC values were significantly greater in the compressed DRG and distal spinal nerves than in intact nerves. Magnetic resonance neurography also showed abnormalities such as nerve swelling at and below the compression in the symptomatic nerve root. Increased ADC values were considered to be because of edema and Wallerian degeneration of compressed nerve roots. The authors concluded that DWI is a potential tool for analysis of the pathophysiology of lumbar nerve roots compressed by herniated disks.

Merlini et al (2011) assessed the feasibility of MR neurography in children, and the potential roles of DWI and fiber-tracking (FT) techniques. A total of 5 pediatric patients (age range of 6 to 12 years) underwent MRI for various clinical indications: neurogenic bladder (case 1); persistent hand pain following minor trauma (case 2); progressive atrophy of the lower left extremity muscles (case 3); bilateral hip pain (case 4); and palpable left supraclavicular mass (case 5). All studies were performed using a 1.5-T Avanto MRI scanner. The protocol included 3D T2-weighted STIR and SPACE imaging, T1-weighted fat-saturation post-gadolinium imaging and diffusion tensor imaging (DTI) with tractography. ADC (N×10(-3) mm(2)/s) and FA values were calculated from ROIs centered on the nerves. Nerve-fiber tracks were calculated using a 4th-order Runge-Kutta algorithm (NeuroD software). Magnetic resonance neurography allowed satisfactory visualization of all neural structures, and FA and ADC measurements were feasible. The final diagnoses were Tarlov cysts, median-nerve compression, sciatic perineurioma, Charcot-Marie-Tooth disease and plexiform neurofibroma in a patient with NF-1. The authors noted that measurements of FA and ADC are of little value because of the lack of normal reference values. Nerve-fiber tractography (FT) may be of value in the characterization of tumor pathology, and is also helpful in the planning of surgical treatments. They concluded that MR neurography is feasible in pediatric patients. However, a considerable amount of work has yet to be done to establish its role in the clinical management of the wide range of peripheral nerve diseases.

The Work Loss Data Institute's clinical guideline on acute and chronic low back pain (2011) listed magnetic resonance neurography as one of the interventions/procedures that are under study and not specifically recommended. Guidelines on ulnar neuropathy from the Washington State Department of Labor and Industries (2010) considered but did not recommend magnetic resonance neurography. Guidelines on radial nerve entrapment from the Washington State Department of Labor and Industries (2010) recommended use of magnetic resonance neurography only in research settings.

The American College of Radiology's Appropriateness Criteria® on "Plexopathy" (2012) stated that "Magnetic resonance neurography, diffusion tensor imaging (DTI), and tractography are exciting developments currently under investigation".

Chung et al (2014) noted that magnetic resonance neurography (MRN) has utility in the diagnosis of many focal peripheral nerve lesions. The authors stated that when combined with history, examination, electrophysiology, and laboratory data, future advancements in high-field MRN may play an increasingly important role in the evaluation of patients with peripheral neuropathy.

Thawait et al (2014) stated that MRN is a specialized technique that is rapidly becoming part of the diagnostic algorithm of peripheral nerve pathology. However, in order for this modality to be considered appropriate, its value compared with current methods of diagnosis should be established. Therefore, radiologists involved in MRN research should use appropriate methodology to evaluate MRN's effectiveness with a multi-disciplinary approach.

The Work Loss Data Institute's clinical guideline on “Shoulder (acute & chronic)” (2013) listed MRN as one of the interventions/procedures that was considered and not recommended.

Birdbaum et al (2014) stated that the diagnosis and treatment of patients with Sjogren syndrome (SS) with neuropathic pain pose several challenges. Patients with SS may experience unorthodox patterns of burning pain not conforming to a traditional "stocking-and-glove" distribution, which can affect the
face, torso, and proximal extremities. This distribution of neuropathic pain may reflect mechanisms targeting the proximal-most element of the peripheral nervous system—the dorsal root ganglia (DRG). Skin biopsy can diagnose such a small-fiber neuropathy and is a surrogate marker of DRG neuronal cell loss. However, SS patients have been reported who have similar patterns of proximal neuropathic pain, despite having normal skin biopsy studies. In such cases, DRGs may be targeted by mechanisms not associated with neuronal cell loss. Thus, alternative approaches are needed to help characterize abnormal DRGs in SS patients with proximal neuropathic pain. These researchers performed a systematic review of the literature to define the frequency and spectrum of SS peripheral neuropathies, and to better understand the attribution of SS neuropathic pain to peripheral neuropathies. They found that the frequency of SS neuropathic pain exceeded the prevalence of peripheral neuropathies, and that painful peripheral neuropathies occurred less frequently than neuropathies not always associated with pain. The investigators developed a novel MRN protocol to evaluate DRG abnormalities. A total of 10 SS patients with proximal neuropathic pain were evaluated by this MRN protocol, as well as by punch skin biopsies evaluating for intra-epidermal nerve fiber density (IENFD) of unmyelinated nerves; 5 patients had radiographic evidence of DRG abnormalities. Patients with MRN DRG abnormalities had increased IENFD of unmyelinated nerves compared to patients without MRN DRG abnormalities (30.2 [interquartile range, 4.4] fibers/mm versus 11.0 [4.1] fibers/mm, respectively; p = 0.03). Two of these SS patients whose neuropathic pain resolved with intravenous immunoglobulin (IVIG) therapy had improvement of MRN DRG abnormalities. The authors concluded that this literature review has demonstrated that many SS neuropathic pain patients do not exhibit neuropathies; these findings suggested an important niche for this MRN DRG technique in the evaluation of broader subsets of SS neuropathic pain patients who may not have underlying neuropathies. The improvement of MRN DRG abnormalities in patients with IVIG-induced remission of neuropathic pain suggested that this MRN protocol may be capturing reversible, immune-mediated mechanisms targeting the DRG. The findings of this small case-series study need to be validated by well-designed studies.

Kitazume et al (2014) examined the feasibility of diffusion-weighted MRN (DW-MRN) for determining the originating nerve of para-pharyngeal schwannomas pre-operatively. A total of 6 patients who underwent DW-MRN pre-operatively for a para-pharyngeal schwannoma were studied. Prediction of the originating nerve was performed. With the conventional method, a tumor showing "separation" between the internal jugular vein and carotid artery was determined to originate from the vagus nerve, with "no separation" from the sympathetic chain. With DW-MRN, the relationships between the vagus nerve and sympathetic chain to the tumor were characterized as "connected" or "dislocated". A nerve connected to the tumor was determined as the origin. Surgeries revealed that the origins included 1 vagus nerve and 5 sympathetic chains. Using a conventional method, all 6 cases were diagnosed correctly, whereas DW-MRN successfully predicted only 4 cases with a sympathetic chain origin. The authors concluded that DW-MRN is a feasible approach for determining an originating nerve.

Wang et al (2014) measured relevant anatomical variables of lumbosacral nerve root and adjacent structures by MRN and analyzed operative safety of transforaminal lumbar interbody fusion (TLIF) in Chinese subjects. A total of 12 normal healthy volunteers (6 men and 6 women) underwent MRN of lumbosacral nerve roots at 3.0 T. Three-dimensional imaging was reconstructed with Osirix software and the following anatomic variables measured: (i) distance between nerve root and upper pedicle; (ii) distance between nerve root and lower pedicle; (iii) angle between nerve root and sagittal plane; (iv) distance between upper and lower nerve roots; and (v) distance between upper and lower pedicles. Good images of the L1 to L5 nerve roots were obtained by MRN technology in all 12 volunteers. The distance between nerve root and upper pedicle and the angle between nerve roots and the sagittal plane gradually diminished from L1 to L5. However, there were no significant variations in the distance between nerve root and lower pedicle or between upper and lower pedicles. From L1 to L2 to L4 to L5, the distances between upper and lower pedicles, which are closely related to the operating space for
TLIF in Chinese men and women, were less than 10 mm in most subjects and were significantly smaller in women than in men. The variables did not differ significantly between the left and right sides of the same segment. The authors concluded that based on the above anatomical study and measurement analysis, they believed that TLIF puts the upper nerve root at risk in some Chinese patients. Moreover, they stated that this conclusion requires confirmation by anatomical study of large samples and clinical validation.

Yoshida et al (2015) noted that there have been no reports of the use of 3-Tesla MRN (3T MRN) to characterize cervical radiculopathy. In particular, there are no reports of MRN of brachial plexus involvement in patients with cervical radiculopathy. These investigators reviewed retrospectively 12 consecutive patients with cervical radiculopathy who underwent 3T MRN. The median age was 54.5 years; 11 of 12 patients were men. The distribution of nerve-root signal abnormality was correlated with intervertebral foraminal stenosis and the presence of muscles that exhibited weakness and/or signs of denervation on EMG. Abnormalities in MRN were found to extend into the distal part of the brachial plexus in 10 patients. The authors concluded that the findings of this study demonstrated that MRN is potentially useful for diagnosis in patients with suspected cervical radiculopathy. Moreover, they stated that the finding of brachial plexus involvement on MRN may indicate a possible pathophysiological relationship between cervical radiculopathy and brachial plexopathy.

Menezes et al (2015) examined the use of DW-MRN in visualizing the lumbar plexus during pre-operative planning of lateral transpsoas surgery. A total of 94 (188 lumbar plexuses) spine patients underwent a DW-MR examination of the lumbar plexus in relation to the L3 to L4 and L4 to L5 disc spaces and superior third of the L5 vertebral body. Images were reconstructed in the axial plane using high-resolution Maximum Intensity projection (MIP) overlay templates at the disc space and L3 to L4 and L4 to L5 interspaces; 10 and 22 mm MIP templates were chosen to mimic the working zone of standard lateral access retractors. The positions of the L4 nerve root and femoral nerve were analyzed relative to the L4 to L5 disc in axial and sagittal planes. Third-party radiologists and a senior spine surgeon performed the evaluations, with inter- and intra-observer testing performed. In all subjects, the plexus was successfully mapped. At L3 to L4, in all but 1 case, the components of the plexus (except the genito-femoral nerve) were located in the most posterior quadrant (zone IV). The L3 and L4 roots coalesced into the femoral nerve below the L4 to L5 disc space in all subjects. Side-to-side variation was noted, with the plexus occurring in zone IV in 86.2 % right and only 78.7 % of left sides. At the superior third of L5, the plexus was found in zone III in 27.7 % of right and 36.2 % of left sides; and in zone II in 4.3 % right and 2.1 % left sides. Significant inter- and intra-observer agreement was found. The authors concluded that by providing the surgeon with a pre-operative roadmap of the lumbar plexus, DW-MRN may improve the safety profile of lateral access procedures. These findings need to be validated by well-designed studies.

In an observational study, Quinn and colleagues (2015) demonstrated use of MRN to visualize the course of the lumbar plexus at the L4 to L5 disc space. Consecutive lumbar plexus MR neurograms (n = 35 patients, 70 sides) were studied. Scans were obtained on a Siemens 3T Skyra magnetic resonance imaging scanner. T1- and T2-color-coded fusion maps were generated along with 3-D models of the lumbosacral plexus with attention to the L4 to L5 interspace. The position of the plexus and the shape of the psoas muscle at the L4 to L5 interspace were evaluated and recorded. Direct imaging of the lumbar plexus using MRN revealed a substantial variability in the position of the lumbar plexus relative to the L4 to L5 disc space. The left-side plexus was identified in zone 2 (5.7 %), zone 3 (54.3 %), and zone 4 (40 %) (p = 0.0014); on the right, zone 2 (8.6 %), zone 3 (42.9 %) or zone 4 (45.7 %), and zone 5 (2.9 %) (p = 0.01). Right-left symmetry was found in 18 of 35 subjects (51.4 %) (p = 0.865). There was no association between the position of the plexus and the shape of the overlying psoas muscle identified. In patients with an elevated psoas (n = 12), the lumbar plexus was identified in zone 3 in 75 % and 66 % (left and right) compared with patients without psoas elevation (n = 23), 30.4 % and 43.5 % (left and right). The authors concluded that the course of the lumbosacral plexus traversing the L4 to L5 disc space may be more variable than has been suggested by previous studies. They stated that MRN may provide a more reliable means of pre-operatively identifying the plexus when compared with current methods. These findings need to be validated by well-designed studies.
In a prospective study, Chhabra and colleagues (2016a) tested the incremental value of 3T MRN in a series of unilateral radiculopathy patients with non-contributory MRI. A total of 10 subjects (3 men and 7 women; mean age of 54 years; range of 22 to 74) with unilateral lumbar radiculopathy and with previous non-contributory lumbar spine MRI underwent lumbo-sacral (LS) plexus MRN over a period of 1 year. Lumbar spine MRI performed as part of the MRN LS protocol as well as bilateral L4 to S1 nerves, sciatic, femoral and lateral femoral cutaneous nerves were evaluated in each subject for neuropathy findings on both anatomic (nerve signal, course and caliber alterations) and DTI tensor maps (nerve signal and caliber alterations). Minimum fractional anisotropy (FA) and mean ADC of L4 to S2 nerve roots, sciatic and femoral nerves were recorded. All anatomic studies and 80% of DTI imaging received a good-excellent imaging quality grading. In a blinded evaluation, all 10 examinations demonstrated neural and/or neuromuscular abnormality corresponding to the site of radiculopathy. A number of contributory neuropathy findings including double crush syndrome were observed. On DTI tensor maps, nerve signal and caliber alterations were more conspicuous. Although individual differences were observed among neuropathic appearing nerve (lower FA and increased ADC) as compared to its contralateral counterpart, there were no significant mean differences on statistical comparison of LS plexus nerves, femoral and sciatic nerves ($p > 0.05$). The authors concluded that MRN of LS plexus was useful for the evaluation of patients with non-contributory MRI of lumbar spine as it could incrementally delineate the etiology and provided direct objective and non-invasive evidence of neuromuscular pathology.

This study has several limitations: (i) being a small pilot study, the authors did not obtain inter- or intra-observer performance assessment, (ii) although there was good correlation of imaging findings, it is not an accuracy study and the authors do not yet have outcomes data, which remains a topic for further research, (iii) there is a spectrum and selection bias, but it could not be avoided, since these researchers wanted to study incremental value of MRN over MR spine studies, and (iv) the authors did not test cervical radiculopathy cases, thus, they could not comment on whether MRN provided any incremental value over MRI in those cases.

Chhabra and colleagues (2016b) examined the feasibility of whole-body MRN (WB-MRN) in polyneuropathy for technical feasibility, distribution of nerve abnormalities, and differentiation. A total of 20 WB-MRN examinations were performed on a 3T scanner over 2 years. Patient demographics including history of hereditary and acquired neuropathy were recorded. The images were evaluated by 2 independent readers with nerve imaging experience for quality. The nerve signal and size alterations were measured in the brachial plexus, LS plexus, and femoral and sciatic nerves; DTI parameters (FA and ADC) were determined in plexuses, and tractography was performed. Non-parametric Wilcoxon rank sum test, receiver operating characteristic (ROC) analysis, and intra-class correlation coefficients (ICCs) were obtained. Excellent image quality was obtained for the majority of LS plexus (18/20) and 50% of brachial plexus (10/20) regions. Qualitatively among cases, the nerve hyper-intensity and/or thickening involved the brachial plexus (11/11), LS plexus (7/11), and both plexuses (7/11), with most nerve thickenings observed in Charcot-Marie-Tooth (CMT) disease type 1. The nerve signal intensity alterations were significantly different for both brachial ($p < 0.05$) and LS ($p < 0.05$) plexuses in cases versus controls. The femoral and sciatic nerve size alterations were different ($p < 0.05$), while signal intensity differences were not significant ($p = 0.1-0.97$). Transverse dimensions of C8 (4 mm), L5 (6.2 mm) and S1 (5.1 mm) nerve roots, and sciatic nerves (10.2 mm) were the most accurate diagnostic performance measures in distinguishing cases from controls. The authors concluded that WB-MRN is feasible for use in the clinical practice for the identification and potential characterization of polyneuropathy. Well-designed studies are needed to ascertain the safety and effectiveness of WB-MRN in the management of patients with polyneuropathy and CMT disease.

Mizuma and colleagues (2016) stated that metastasis of breast cancer is often detected through a long-term course and difficult to diagnose. These investigators reported a case of brachial plexopathy suspected to be the initial lesion of breast cancer metastasis, which was only detected by MRN. A 61-year old woman was admitted to the authors' hospital within 2 years after operation for breast cancer because of progressive dysesthesia and motor weakness initially in the upper limb on the affected side.
and subsequently on the contralateral side. Enhanced computed tomography (CT), axillary lymph node echo, gallium scintigraphy, and short tau inversion recovery MR images showed no abnormalities; MRN revealed a swollen region in the left brachial plexus. These investigators suspected neuralgic amyotrophy and initiated treatment with intravenous immunoglobulin (IVIG) therapy and steroid therapy. However, there was no improvement, and the progression of motor weakness in the bilateral lower limbs appeared over 4 years. Concomitant elevation of carbohydrate antigen 15-3 level (58.9 U/ml) led to suspect breast cancer metastasis, which was associated with the worsening of neurological findings, although gallium scintigraphy and bone scintigraphy showed no inflammatory and metastatic lesions. Swelling of the cauda equina in enhanced lumbar MRI and abnormal accumulation at the brachial plexus and cervical spinal cord in positron-emission tomography (PET) were newly detected contrary to the normal findings on the gallium scintigraphy, which suggested cerebrospinal fluid seeding. The authors suspected breast cancer metastasis about the initial brachial plexopathy based on the clinical course. They stated that MRN may be a helpful tool to detect metastatic lesion, especially in nerve roots.

Bao and colleagues (2016) examined the feasibility of DW-MRN in the visualization of extremity nerves in the wrist and palm. A total of 32 volunteers and 21 patients underwent imaging of the wrist and palm on a 3T MR scanner. In all subjects, 2 radiologists evaluated the image quality on DW-MRN using a 4-point grading scale. Kappa statistics were obtained for inter-observer performance. In volunteers, the Chi-squared test was used to assess the differences in nerve visualization on DW-MRN and axial fat-suppressed proton density weighted imaging (FS-PDWI). In volunteers, the mean image quality scores for the median nerve (MN) and ulnar nerve (UN) were 3.71±0.46 and 3.23±0.67 for observer 1, and 3.70±0.46 and 3.22±0.71 for observer 2, respectively. The inter-observer agreement was excellent (k = 0.843) and good (k = 0.788), respectively. DW-MRN provided significantly improved visualizations of the 2nd and the 3rd common palmar digital nerves and 3 branches of UN compared with FS-PDWI (p < 0.05). In patients, the mean image quality scores for the 2 observers were 3.24±0.62 and 3.10±0.83, inter-observer performance was excellent (k = 0.842). The authors concluded that DW-MRN is feasible for improving visualization of extremity nerves and their lesions in the wrist and palm with adequate image quality, thereby providing a supplementary method to conventional MR imaging. Well-designed studies are needed to ascertain the safety and effectiveness of DW-MRN in the evaluation of median and ulnar nerves in the wrist and palm.

Wadhwa and co-workers (2016) stated that pudendal neuralgia is being increasingly recognized as a cause of chronic pelvic pain, which may be related to nerve injury or entrapment. Due to its complex anatomy and branching patterns, the pudendal nerve abnormalities are challenging to illustrate. The authors noted that high-resolution 3T MRN is a promising technique for the evaluation of peripheral neuropathies.

Yamashita and associates (2017) evaluated the potential of readout-segmented echo-planar DW-MRN (RS-EPI DW-MRN) for the selective visualization of pelvic splanchnic nerve and pelvic plexus in healthy male volunteers. Institutional review board approval and written informed consent were obtained; RS-EPI DW-MRN images were acquired from 13 healthy male volunteers aged 25 to 48 years between September 2013 and December 2013. For RS-EPI DW-MRN, the following parameters were used: spatial resolution, 1.1×1.1×2.5 mm; b-value, 250 s/mm2; number of readout-segments, 7; and acquisition time, 7 minutes 45 seconds. For qualitative assessment, 2 abdominal radiologists independently evaluated the visibility of the pelvic splanchnic nerves and pelvic plexuses bilaterally in each subject on oblique coronal thin-slab 10-mm-thick maximum intensity projection images and scored it with a 4-point grading scale (excellent, good, fair, poor). Both readers scored twice at 6-month intervals. Inter-observer and intra-observer variability were evaluated using Cohen's quadratically weighted κ statistics. Image artifact level was scored on a 4-point grading scale by other 2 abdominal radiologists in order to evaluate the correlation between the nerve visibility and the severity of imaging artifacts using the Spearman's correlation coefficient. Qualitative grading showed the following success rate (number of nerves qualitatively scored as excellent or good divided by total number of nerves): reader 1 (first set), 73 % (19/26); reader 2 (first set), 77 % (20/26); reader 1 (second set), 81 % (21/26); and reader 2 (second set), 77 % (20/26). Inter-observer agreement
between readers 1 and 2 was excellent: \( \kappa = 0.947 \) (first set) and 0.845 (second set). Intra-observer agreement was also excellent: \( \kappa = 0.810 \) (reader 1) and 0.946 (reader 2). The visibility of pelvic splanchnic nerve and pelvic plexus showed a moderate correlation with the image artifact level (\( \rho = 0.54, p = 0.004 \)). The authors concluded that the findings of this study demonstrated that RS-EPI DW-MRN is a promising approach for selectively visualizing the pelvic splanchnic nerve and pelvic plexus.

In a pilot study, Bao and co-workers (2017) examined the applicability of DW-MRN in the diagnosis of carpal tunnel syndrome (CTS). A total of 47 patients with CTS (69 wrists) and 19 normal participants (38 wrists) were included in this study. Cross-sectional area (CSA) and ADC values of the median nerves in the carpal tunnel were determined using DW-MRN; ROC analysis was performed. No significant differences in age or body mass index (BMI) were observed between the control and CTS groups. DW-MRN imaging showed obvious hyper-intensity in the lesions in CTS wrists, while other nerve regions were related to slight hyper-intensity. Inter-observer variability analysis indicated excellent agreement regarding both the CSA and ADC measurements for the control and CTS groups. Both the mean CSA and ADC values of the median nerves in carpal tunnel in the CTS group were significantly higher than the control group. According to the ROC analysis, the CSA cut-off value was 11.7 mm2, and sensitivity and specificity were 66.7 % and 89.5 %, respectively. In contrast, the median nerve ADC cut-off value was 1.047\times10^{-3} \text{mm}^2/\text{s}. The sensitivity and specificity were 91.3 % and 76.3.9 %, respectively. The authors concluded that DW-MRN represents a highly reproducible diagnostic technique for CTS. The ADC value of median nerves in the carpal tunnel was significantly higher in CTS patients, which provides a potential powerful tool for the disease diagnosis.

Currently, the sensitivity, specificity, as well as PPV and NPV of MR neurography in the diagnosis and management of patients with peripheral nerve disorders remain unclear. Thus, the accuracy and clinical value of MR neurography has yet to be established.

### CPT Codes / HCPCS Codes / ICD-10 Codes

Information in the [brackets] below has been added for clarification purposes. Codes requiring a 7th character are represented by "+":

ICD-10 codes will become effective as of October 1, 2015:

There are no specific codes for magnetic resonance neurography:

ICD-10 codes not covered for indications listed in the CPB (not all-inclusive):

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<td>Nerve, nerve root and plexus disorders</td>
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<td>Injury to nerves and spinal cord</td>
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The above policy is based on the following references:


43. Quinn JC, Fruauff K, Lebl DR, et al. Magnetic resonance neurography of the lumbar plexus at
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Amendment to
Aetna Clinical Policy Bulletin Number: 0387 Magnetic Resonance Neurography

There are no amendments for Medicaid.