Neurovascular Sonography: What Price Victory?

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MR Imaging of the Lower Leg versus Clinical Electrophysiologic Examination in the Differential Diagnosis of Neurogenic Foot Drop

Patients with foot drop are frequently seen in clinical practice. Foot drop may be due to a lesion of the common peroneal nerve, L5 radiculopathy, or a partial sciatic nerve lesion or lesions involving the lumbosacral plexus or cauda equina. Nerve conduction studies and electromyography (EMG) are of great help in localizing the site of the lesion. EMG can help detect evidence of denervation in foot drop of recent onset and can also help in establishing evidence of reinnervation in more chronic lesions.

Since the description by Polak et al (1) of significant MR signal intensity changes in denervated muscles, several other articles have been published documenting MR signal intensity changes in the denervated muscles. An article by Bendszus et al in this issue of the *AJNR* compares MR findings of the lower leg with those of clinical and electrophysiologic examination in the differential diagnosis of neurogenic foot drop (2). In a prospective study with a total of 40 patients, 20 had peroneal nerve lesions, nine had L5 radiculopathy, and 11 had other lesions to account for the foot drop. MR imaging included axial T1-weighted and turbo inversion recovery magnitude (TIRM) images of the lower leg. The MR images were evaluated for patterns of signal intensity increase on TIRM images by two readers blinded to the clinical data. Three distinct patterns of signal intensity increase on TIRM images were noted: peroneal nerve pattern, L5 pattern, and nonspecific pattern. T1-weighted images were used for localizing the muscles. The electrophysiologic studies were performed within a week after MR studies. MR imaging and EMG were in agreement in 37 of the 40 patients. In three patients, MR imaging demonstrated a more widespread involvement than did EMG. In one of the patients with combined L5 and S1 radiculopathy, evidence of denervation was noted on MR images, but not on EMG, because only one of the two heads of gastrocnemius muscle was studied by EMG. In another patient who had a lesion of the peroneal nerve, MR imaging showed increased signal intensity on TIRM images in the distal parts of the anterior tibial compartment muscles, whereas the proximal anterior compartment muscles were normal. EMG showed no evidence of denervation, and repeat study showed evidence of denervation only in the distal parts of the muscles. On the basis of their findings, the authors claim that, in selected patients with acute and subacute denervation, MR imaging may be more accurate than EMG in the differential diagnosis of peripheral nerve lesions. Failure to examine sufficient numbers of muscles is a frequent cause for not detecting denervation on EMG. It is preferable to examine at least three muscles innervated by the same segment and three muscles innervated by the same peripheral nerve. It is also important to examine different parts of the same muscle.

MR imaging offers several advantages. It is noninvasive and is more easily tolerated by children. As a rule, EMG is not performed in patients receiving anticoagulants or with a bleeding diathesis. The entire cross section of the muscles can be studied by MR imaging, whereas all areas of the muscle are not examined by EMG. MR imaging can determine the degree of atrophy, hypertrophy, and fatty replacement of muscle fibers. In addition, there does not appear to be an interobserver variation in the interpretation of MR findings.

There are also some disadvantages to MR imaging. The more proximal muscles innervated by the same segments were not examined by MR imaging. Although evidence of acute and subacute denervation is easily seen, it does not apply to chronic neurogenic changes.

During EMG, several proximal and distal muscles can be examined, and paraspinal muscle evaluation may add additional information and help in the differential diagnosis of lesions of the lumbosacral plexus and cauda equina. In addition to evidence of denervation, reinnervation changes can be documented by EMG. Sensory nerve conduction studies are very helpful in differentiating lesions proximal to the dorsal root ganglion (DRG) from lesions that are distal to DRG. The sensory nerves are tested distally, and the sensory nerve action potentials will be abnormal in lesions distal to the DRG because of the interruption, anatomic or physiologic, of the distal sensory fibers from their cells of origin in the DRG. EMG is an invasive procedure, and there is a certain degree of discomfort associated with it. The expertise of the electromyographer plays a major role in the quality of the studies.

In a study comparing MR imaging of denervated muscle and EMG by McDonald et al (3), MR imaging had a relative sensitivity of 84% and specificity of 100% for detecting denervation. Increased MR signal intensity corresponded closely with evidence of denervation on EMG. They concluded that, although less sensitive than EMG in detecting muscle denervation, MR changes in signal intensity of denervated muscles were useful as adjunctive diagnostic tools in that setting.

There has been considerable excitement in the past several years about MR imaging of peripheral nervous system. The studies by Maravilla and Bowen (4) have proved to be valuable not only in localizing the anatomic site of the lesion, but also in determining the nature of the likely pathologic condition. With future advances in technology, it is likely that we will be able to arrive at a correct diagnosis in many patients with unexplained lesions of the peripheral nervous system

MR signal intensity changes in detecting muscle denervation seem to be a useful technique and can be used in addition to EMG. Whether the MR technique will be used routinely in the future remains to be seen.

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The article by Friedman and Maitino (1) that appears in this month's *AJNR* is quite timely. The authors demonstrate the low rate of neurovascular sonography performance by academic neuroradiologists (11%) who are responsible for the training programs for neuroradiology fellows. When the program directors (PDs) of neuroradiology fellowships are therefore required to ship their fellows off to other services either within the department of radiology or with other departments in the hospital for this training, there is little accountability for the quality of this training. This has led to a strong sentiment for revoking the 2-week neurovascular sonography requirement defined by the Accreditation Council for Graduate Medical Education (ACGME) standards for neuroradiology fellowships ("2–4 weeks or equivalent dedicated experience performing and interpreting vascular sonography," from the www.acgme.org website).

The paradox is Friedman and Maitino's finding that, in 53% of private practice settings, neuroradiologists are engaged in performing neurovascular sonography. Although this number seems surprisingly high, the authors investigate in a somewhat superficial manner the total volume of cases performed by neuroradiologists and conclude that they account for 32% of the cases performed by radiologists in general or 15% of carotid sonography procedures performed throughout the private institutions. At both the academic centers and the private practice settings, nonradiologists perform a substantial number of the carotid sonography examinations (58% and 42% respectively). The workload is largely performed by vascular surgeons, neurologists, and cardiologists.

A 2003 American Society of Neuroradiology (ASNR)–sponsored Internet survey of fellowship PDs and ASNR members on attitudes toward neurovascular sonography produced similarly interesting results. Seventy PDs and 464 ASNR members responded, representing 77% of program directors and approximately 16% of the ASNR, respectively. Thirty-nine percent of PDs and 29% of members surveyed said the sonography requirement should be completely eliminated from the fellowship program. Fifty-one percent of PDs and 57% of members thought sonography should be recommended, but not required, during fellowship training. Only 10% (7/70) of PDs and 14% (63/464) of ASNR members felt that sonography should be a required element of neuroradiology fellowship training. In summary, 90% of PDs and 86% of members thought that the ACGME criterion of mandating 2 weeks of neurovascular sonography training should be removed.

In the ASNR survey, only 9% of fellowship PDs and 35% (166/464) of members surveyed performed neurovascular sonography as part of their practice. Of the 166 physicians who performed neurovascular sonography, 84% stated that it constituted <5% of their practice, whereas the remaining 16% said it constituted only 5–25% of their practice. In no instance did neurovascular sonography exceed 25% of the work currently performed.

Twenty-six percent of the 464 members said neurovascular sonography training was not applicable in their practice, 33% felt it was minimally applicable, and 24% found it somewhat applicable. Fourteen percent thought it was very applicable, and only 2% thought sonography was critical to practice. In summary, most (94%) trained neuroradiologists thought neurovascular sonography training had little role in their practice (65% who do not perform sonography at all and 29% for whom it represents <5% of their casework). Thus, sonography represents >5% of practice for only 5.6% of neuroradiology fellowship program graduates. Many respondents also thought that the training in residency was sufficient.

But there is a dilemma. The American College of Radiology (ACR), in an effort to preserve the turf of neurovascular sonography for radiologists, would delight in supporting neuroradiologists as the champions of neurovascular imaging. After all, we have mastered the technical challenges of CT angiography (CTA), MR angiography (MRA), and digital subtraction angiography. We know the vascular anatomy of the neck and brain better than any other specialists in radiology. By keeping neurovascular sonography under the rubric of neuroradiology and making its training a requirement in a certificate of added qualification program, the ACR can solidify radiology's claim to this technique.

Vascular surgeons and cardiologists undoubtedly covet this diagnostic procedure, and neurologists likewise also desire to plant a flag in a "procedure" that yields more revenue than their lengthy neurologic examination.

Nonetheless, most neuroradiology PDs have ambivalence about the technique. Although we see its value, we are much more concerned about teaching our trainees about more "relevant" newer radiologic techniques such as CTA, MRA, diffusion imaging, perfusion imaging, MR spectroscopy (if only it would be reimbursed by Medicare again!), functional imaging, and positron emission tomography. Most wish to do away with the 2-week requirement and allow the PDs to decide how and what to train their fellows.

On February 18, 2003, we won the battle. The Radiology Residency Review Committee (RRC) of the ACGME, responding to a request made by the PDs and the President of the American Society of Neuroradiology, elected to rescind the requirement for 2 weeks of neurovascular sonography training in the 1-year neuroradiology fellowship. The RRC presumably accepted the argument made that the training in neurovascular sonography one receives, as part of the 4-year radiology residency, was sufficient to practice this technique effectively. A struggle that has been 3 years in the making was "successfully" concluded. Was this the correct road to take? How many neuroradiology PDs will continue to provide fellows with the extra time to perfect neurovascular sonography, now that it is no longer required? Have we abandoned one frontier to nonradiologists? Can we continue to claim to be the experts in the field?

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