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Advancing Techniques in Spinal MR Imaging: But Are They Necessary for Spinal Leptomeningeal Tumor?

Sugahara et al, in this issue of the *American Journal of Neuroradiology* (page 1773), compare the 2D spin-echo (2D-SE) technique with the 3D gradient-echo (3D-GE) technique after contrast injection in order to determine which sequence is superior for the evaluation of suspected leptomeningeal tumor in the spine. The authors found that the 2D-SE technique depicted the fewest lesions. The 3D-GE technique depicted a greater number of lesions, but the best lesion depiction was achieved with the 3D-GE technique combined with multiplanar reconstruction. In addition, the authors found that the use of reconstruction was helpful in distinguishing vascular enhancement. Therefore, they suggest that the 3D-GE technique in combination with multiplanar reconstruction should be used for detecting intradural tumor dissemination.

This article is the first to compare the use of 2D-SE and 3D-GE techniques in the evaluation of contrast-enhancing lesions in the spine. Certainly, 3D techniques are now routinely used in imaging of the spine and in other applications. In particular, 3D-GE or 3D fast spin-echo imaging techniques are commonly used for the evaluation of extradural disorders, such as disk disease. Typically, with the 3D-GE technique, low flip angles are used to create hyperintensity in the CSF, allowing differentiation and delineation of disk from CSF. The use of 3D-GE techniques with spoiler gradients, to achieve an essentially T1-weighted effect, in combination with contrast material, has been much less common. Up to now, the primary use of 3D-GE techniques has been limited to the examination of patients with degenerative changes (1). Here again, the use of the 3D-GE technique, in combination with contrast enhancement and spoiler gradients, has been shown to provide good delineation of small disks. In these cases, however, it is often vascular enhancement that is being examined rather than enhancement of the lesion itself.

The current study used a 3D-GE technique in combination with spoiler gradients and contrast enhancement to detect enhancing tumors. While work of this sort has not been performed in the spine, it has been done in the brain. There, the technique has had mixed results. Some have advocated its advantages. For example, the 3D technique has been shown to offer better spatial resolution because much thinner sections can be achieved. In addition, such thin sections have allowed reformations to be performed. If a patient has been imaged in one plane but examination of the lesion in another plane is desired, reformations are easy to perform. Reformations can even be performed in oblique planes. The 3D-GE technique is also more sensitive to flow-related phenomena than are 2D-SE techniques, and the 3D-GE technique, of course, forms the basis for time-of-flight MR angiography. With the use of contrast material, shortening of the T1 relaxation time is also achieved, allowing even better delineation of vessels. Finally, 3D-GE images are more sensitive to susceptibility effects than are 2D-SE images, permitting better detection of hemorrhagic lesions.

In contrast, others cite the disadvantages of the 3D-GE technique in the evaluation of enhancing brain lesions. First, several studies have demonstrated that contrast-enhancing lesions do not seem to be as visible with the 3D-GE technique as with the 2D-SE technique. With this point in mind, it is interesting that Sugahara et al use a dose of 0.15 mmol/kg of contrast material, which is 50% higher than that normally used. Second, 3D-GE images are more sensitive to patient motion, because of the need to position the phase-encoding gradient in two axes as opposed to one.

The optimal technique would combine the advantages of the 3D-GE technique with those of the 2D-SE technique. At the time that the study discussed here was performed, section thickness in the 2D-SE technique was limited; in general, it was not possible to acquire sections thinner than 3 mm, and Sugahara et al used 4-mm-thick sections. Recently, improvements in gradient strength and profile have allowed the capability to obtain much thinner sections. With state-of-the-art machines, it has become routinely possible to acquire sections as thin as 0.9 mm with the 2D-SE technique. When sections as thin as this can be obtained, many of the advantages of the 3D-GE technique disappear. First, these sections are so thin that reformations can be performed. Second, any dispute about the relative visibility of contrast-enhancing lesions on images obtained with the 3D-GE technique is eliminated. Third, the potential difficulty of increased motion artifacts with the 3D-GE technique, even though these were apparently not problematic in the current study, is eliminated. While 2D-SE scans using very thin sections would not be practical in the brain, where large distances need to be covered, they can be used in the spine, where the distance between neural foramina is not so great.

When compared with ultra–thin section 2D-SE techniques, very few advantages of the 3D-GE technique remain. Its greater sensitivity to magnetic susceptibility is less advantageous in the spine, where small hemorrhagic lesions are much less common. In fact, increased magnetic susceptibility artifacts can be a problem in patients with extensive degenerative change or in those with a history of previous spinal surgery. The ability of 3D-GE techniques to increase the visibility of vascular lesions is also not as useful in the spine, where detection of aneurysms or other small-flow lesions is not common.

Clearly, technical achievements allow us to refine and develop our imaging capabilities continually so that detection and improved delineation of smaller

and smaller lesions become possible in the spine. One crucial question remains: Are these refinements really of use for patient care? Previous studies have shown that the evaluation of spinal leptomeningeal tumor by imaging criteria is not perfect. In patients with known leptomeningeal tumor in the spine, detection rates have ranged from approximately 33% to 66% with the use of standard 2D-SE techniques with a 3- to 5-mm section thickness (2, 3). The reason the detection rate has not been higher is usually because the disease is microscopic, not because of a lack of detection of small nodules. When the effectiveness of imaging techniques is compared with evaluation of CSF for cytology, then a striking difference is noted. Evaluation of CSF can be far more sensitive for the detection of leptomeningeal tumor. In patients with known leptomeningeal tumor, after one lumbar puncture, positive cytology is found in approximately 45%. After three consecutive lumbar punctures, positive cytology is detected in approximately 85%. After six consecutive lumbar punctures, the detection rate is 95%. In addition, in some cases, increased detection rates can also be achieved by performing cervical rather than lumbar punctures.

Since better detection of leptomeningeal tumor can be achieved through examination of CSF rather than by imaging studies, what is the use of imaging studies? In many cases, the presence of leptomeningeal tumor is already known. If tumor nodules can be demonstrated, however, then treatment can be directed at the tumor nodules, in addition to whatever other therapy the patient is receiving. For example, patients with known leptomeningeal tumor of the spine from systemic tumors may receive intrathecal chemotherapy combined with radiation directed at the tumor nodules themselves. This approach has been shown to provide the greatest therapeutic benefit. Clinically, therefore, detection of very small nodules, using the preciseness that the latest techniques allow, may not be necessary.

In conclusion, then, advances in technology have allowed us to provide better and better evaluations of enhancing lesions of the spine. Both 3D-GE techniques and ultra–thin section 2D-SE techniques may provide the most optimal delineation of small-lesion enhancement. Clinically, there will be selected cases in which this will be useful; for example, in the evaluation of suspected inflammatory disease, such as sarcoid, where no other laboratory tests to assess CNS involvement are available. For routine use, however, we may well have achieved what is necessary for clinical utility even before the application of these technological advances.

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