. . . But will it play in Peoria?

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daily work lives—concepts and terms that are now second nature to our specialty. It is very possible that in another decade words such as *sonic hedgehog, notch, astrotactin, merosin, laminin 1*, and *laminin 2* will be household words for the practicing neuroradiologist, and we will be as comfortable using them in our vocabulary and discussion of diagnostic imaging studies as we have become with *T1* and *T2*.

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. . . But Will It Play in Peoria?

Call me jaded, call me cynical, or simply call me battered by the heavy and still growing load of a community managed care MR practice. More and more when I read the "literature," I find myself spending less and less time reading those articles written for the academic audience, ones for which I will likely never find an application in pragmatic practice. Am I losing my religion? Or is it simply harder these days to produce innovative, clinically relevant research since little new is heading down the highway of the technological imperative? On the other hand, initially "impractical" developments may stimulate new avenues of implementation that ultimately produce considerable impact on clinical practice.

LeClerc et al in this issue of the *American Journal of Neuroradiology* (page 1405) present a worthwhile attempt to extend the clinical relevance of MR angiography in the evaluation of patients with cerebrovascular disease. The authors' stated purpose is to evaluate this technique's ability to image the carotid and vertebral arteries in their cervical portions, and to compare this technique with conventional angiography in this setting. The innovative wrinkle here is the combined use of an intravenous contrast bolus—a coronal 3D slab acquisition allowing rapid sampling of a vertically large field of view and a head-and-neck surface coil—another technowrinkle. The proposed use of a single contrast bolus and this coil architecture to evaluate the cervical-cranial vasculature in one fast shot certainly is seductive, particularly given the subminute study time, and, if successful, it would likely reach Peoria quickly. But two questions must be addressed. Is there a need? and Does the technique deliver?

The authors acknowledge in their introduction that three-dimensional time of flight MR angiography (3D MRA) is an effective technique, but point to its limited anatomic coverage while incorrectly stating that it does not allow the evaluation of both the anterior and posterior circulations. In our experience, working with the same MR instrument that LeClerc et al used for this study, we find the combination of multislab 3D MRA of the neck and 3D MRA of the brain quite effective in depicting both the anterior and posterior circulations in the neck and brain, albeit with the need for one half-hour time slots for each patient's study (this includes the anatomic brain MR imaging as well). Indeed, we routinely study three to four patients a day with these techniques, such patient volume testifying to the reliability and clinical value provided to the referring clinicians. Nevertheless, the limitations of these now "conventional" MRA techniques, particularly for evaluating the arch and ostia of the major vessels, are well-known and have been elucidated in the literature. Fortunately these limitations have not deterred our referral base to any significant degree.

Yes, it would be nice to have a technique that allowed visualization of the arch origins, the cervical course, and the intracranial distribution of the cerebral blood supply. And herein lies the contribution of LeClerc et al. Their experience clearly suggests the potential role of the contrast-enhanced fast 3D technique for the evaluation of the arch origins and cervical course of the intracranial vessels. The results of the contrast-enhanced coronal FISP technique in the full coverage of the cervical-cranial distribution are, however, disappointing. The failure to demonstrate the ostium in 35% of the cases was particularly disappointing—almost as disappointing as the inability to evaluate the carotid siphon in 35% of the cases. "Conventional" MRA's difficulties with flow-related artifacts apparently haunt the contrast-enhanced technique in this early stage as well. In short, at the present time this technique cannot be used in Peoria or elsewhere to completely evaluate suspected cerebrovascular disease. It even falls short of the current MRA technique used for that purpose, assuming one is willing to trade off visualization of the aortic ostia for the carotid siphon and basilar artery evaluation. The limitations of this technique are magnified when one considers the additional costs of intravenous contrast material and the fact that it offers only a "one-shot" deal. Although the authors do describe a second contrast-enhanced MRA study performed in six patients because of the failed first go-around, the quality of those studies is not specifically addressed. The venous contrast, and that in the extracellular space, would not likely produce pleasing images.

What then will the practicing radiologist take away from this article? First, the concept of a combined head and neck coil has considerable appeal, and such "combo coils" will soon be widely used. At the very least, the current "conventional" cervical-cranial MRA techniques can be supplemented with the technique described by LeClerc et al for evaluation of the aortic arch and proximal cervical vasculature. Second, with further technical development, it is likely that coverage can be extended to allow visualization of the ostia and the carotid siphons in one acquisition. Newer contrast agents that do not exit the intravascular space will optimize the ability to do repeated MR sequences after only a single injection, thus providing the "payoff" of very rapid coronal slab sequences obtained sequentially, while maintaining significantly high intravascular signal to limit flow-related artifacts. Thus, LeClerc et al take another step up the stairway, the top of which is the complete replacement of conventional angiography with MRA for evaluation of cerebrovascular disease.

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Detection of Perineural Spread: Fat Is a Friend

One could easily argue that the search for perineural tumor spread is the most important task of the radiologist examining a patient with head and neck carcinoma.

Certainly the description of a primary tumor site is important. The relationship of tumor to bone has definite implications in surgical and radiation treatment planning. Many imaging findings alter the surgical plan, but adjustments, though important, tend to be relatively minor. Nodal metastases are a definite determinant of prognosis, but the changes in therapy effected by imaging definition of nodal metastasis are relatively few. The discovery of a tumor that follows a nerve to or through the skull base, however, has an immediate and profound effect on the perception of a patient's disease. The chance for surgical cure plummets, long-term prognosis is significantly changed, and alternative therapies are considered. Detection of perineural spread is crucial. The findings can be very subtle, and the radiologist must seek out any help available.

In any discussion of perineural spread, terminology is important. *Perineural tumor spread* must be distinguished from the designation *perineural tumor* that can be found in the histopathologic report of a primary lesion. The report of perineural tumor in a pathologic report indicates the relationship of tumor to a nerve. This designation may have an effect on prognosis, but does not necessarily imply that the tumor has left the primary area. In perineural tumor spread, the tumor actually appears to use the nerve as a conduit, selectively following the nerve away from the primary site. The tumor moves through the skull base along the same path as the affected nerve. This route allows apparent distant tumor spread because tissues in between remain relatively undistorted.

Ginsberg and DeMonte in this issue of the *American Journal of Neuroradiology* (page 1417) give an excellent demonstration of one of the most important of these perineural pathways: the second division of the trigeminal nerve from palate to pterygopalatine fossa through foramen rotundum to Meckel's cave. Their superb images show the key findings of perineural tumor spread. There is enlargement of the affected foramen, enhancement of the nerve, mass effect in the Meckel's cave region, and obliteration of the fat in the pterygopalatine fossa. I would like to emphasize the importance of this last finding: obliteration of normal fat just external to the neural foramen.

Each of the major head and neck neural pathways transit some amount of fat immediately external to the skull base. The first division of the trigeminal (ophthalmic) neural pathway, which potentially carries tumor from the lacrimal gland, passes through the fat of the superior orbital fissure. The second division trigeminal (maxillary), with connections to the face, palate, and maxillary sinus, must traverse the fat-filled pterygopalatine fossa just external to the foramen rotundum. The third division (mandibular) can carry tumor from connections of the submandibular gland, parotid gland, or potentially, the oral cavity through the foramen ovale. Immediately below the foramen ovale, a fat pad sits just medial to the lateral pterygoid muscle. Tumor following the path of this nerve must traverse this fat before entering the skull base. The facial nerve passes though the fat of the stylomastoid foramen before penetrating the temporal bone. The hypoglossal and glossopharyngeal nerves pass through a small amount of fat as they follow the carotid and jugular just below the skull base.

Tumor has an appearance very different from fat on both CT and on T1-weighted MR images. In our experience this fat is, therefore, very sensitive to tumor spread. An enlarging nerve obliterates that fat so tumor can be detected. Conversely, demonstration of an intact fat pad is a reassuring finding, indicating strongly that the tumor has not passed the fat pad. Thus, the radiologist should be aware not only of the important neural pathways and the foramen that each traverses but also of the fat pad or fossa sitting immediately external to the particular foramen. Obliteration of this fat is often the first, and perhaps the easiest, finding for the radiologist to appreciate.

Which fat planes or pads are most crucial? This certainly depends on the site of the primary tumor in question. Although many tumors such as lymphoma,