AJNR

Advanced CT and MR Imaging Techniques: An Academic Whim or a Clinical Standard in the Making?

M. Wintermark and W.P. Dillon

AJNR Am J Neuroradiol 2006, 27 (6) 1257
http://www.ajnr.org/content/27/6/1257

COMMENTARY

Advanced CT and MR Imaging Techniques: An Academic Whim or a Clinical Standard in the Making?

The last decade has seen an increase in the development and application of various functional imaging techniques, such as MR spectroscopy, diffusion- and perfusion-weighted MRI, perfusion CT, optical imaging, and nuclear medicine–based tools. These functional imaging techniques address conditions as diverse as cerebrovascular disorders, seizures, cardiac and lung function disorders, tumors of the brain, head and neck, liver and prostate, and others.

The implementation of many of these more advanced, time-consuming functional methods has lagged behind that of conventional MR imaging techniques. Multiple reasons account for this observation, among which are the lack of physician/clinician education, the absence of standardization, and delays in reimbursement by Medicare and, therefore, by many private insurers. As a consequence, it is difficult to devote time and resources to learn these techniques, to teach them to the technologists, or to develop and support advanced imaging laboratories. In addition, CT and MR technologies are evolving so quickly that it is difficult merely to keep up with the new developments.

In the face of these issues, mounting evidence showing the clinical utility of many of these functional techniques is accumulating. Studies such as the one reported by Noguchi et al,[1] which describes the perfusion-weighted MR findings in 12 patients with angiographically confirmed dural arteriovenous fistulas (AVFs), illustrate the added value offered by advanced imaging techniques applied to common clinical conditions. Noguchi et al report higher cerebral blood volume (CBV) values in the hemispheres of patients with AVFs with angiographically confirmed retrograde cortical venous drainage, as compared with normal CBV values in those with no retrograde flow and in controls. Also, a significant decrease in hemispheric CBV was observed after treatment of patients with preoperative retrograde cortical venous drainage.

AVFs have been classified according to the type of cerebral venous drainage.[1] Grade 1 AVFs exhibit no venous restriction and normal anterograde venous drainage. Grade 2 AVFs exhibit anterograde and retrograde venous drainage, with or without cortical venous drainage. Grade 3 AVFs demonstrate retrograde and cortical venous drainage without anterograde drainage. Grade 4 AVFs exhibit only cortical venous drainage. Increasing AVF grade is directly proportional to the risk of neurologic complications.[2] Patients with grade 1 or 2 AVFs exhibit a benign clinical presentation, primarily with pulsatile tinnitus and headaches. Patients with grade 3 AVFs demonstrate a 31% incidence of both visual symptoms and intracranial hemorrhage. Patients with grade 4 AVFs demonstrate a 67% incidence of visual symptoms and a 100% incidence of intracranial hemorrhage. Patients with grade 3 or 4 AVFs are thus at high risk and require urgent decisive treatment.[1]

Increased CBV values on perfusion-weighted MR images in patients with AVF is most likely an indicator of intracranial venous hypertension and probably a predictor of complications such as edema or hemorrhage. This functional imaging pattern might well influence the decision for a more aggressive treatment strategy in such patients, even if retrograde venous drainage is not visible on CT or MR angiography.

This observation is extremely interesting because it makes use of functional cross-sectional imaging as both a potential selection criterion for treatment and a monitoring tool for treatment efficacy. Similar efficacy studies, such as the use of perfusion-weighted MR imaging to determine which meningiomas should be embolized, which patients with acute stroke should receive thrombolysis, and which tumor-mimicking lesions should be left alone have been reported. In these studies, functional imaging techniques were shown to provide unique, clinically valuable information not available from conventional morphologic imaging. Treatment stratification based on functional imaging may result in improved patient care and reduced health care costs. Also, the idea that functional imaging could potentially substitute to clinical observation as an end point for treatment efficacy has critical repercussions for clinical trials, because they may significantly reduce the number of patients required to show the efficacy of a treatment and, as a result, lower the costs of conducting multicenter trials.

It is essential that advanced CT and MR imaging techniques be embraced within the community of practicing radiologists. To justify reimbursement, some actions are required: (1) Academic institutions, societies, and manufacturers should work together to organize prospective, large-scale, multicenter trials to test these advanced techniques and assess their efficacy in the patient care arena. (2) The postprocessing involved in these techniques should be made as automated and user-friendly as possible and integrated into the CT and MR scanner operator consoles to minimize the efforts needed once raw data are acquired. This will permit the final end user to have access to images via PACS or teleradiology, as well as improve workflow during the day; (3) Improved training in these techniques should be facilitated by academic institutions and professional societies through hands-on courses, workshops, and focused seminars. (4) Finally, because most of these techniques require no additional contrast and only minimal additional scanning time, practitioners should implement them, regardless of their reimbursement status, and use tracking current procedural terminology (CPT) codes, if available, as soon as the techniques are shown to be efficacious. This will build a geographically diverse experience, which is one of the requirements for obtaining reimbursement codes. These are necessary conditions to facilitate the penetration of advanced CT and MR imaging techniques into the community, ultimately improving and benefiting patient care.

References

1. Noguchi K, Kubo M, Kuwayama N. et al. **Intracranial dural arteriovenous fistulas with retrograde cortical venous drainage: assessment with cerebral blood volume by dynamic susceptibility contrast magnetic resonance imaging.** *AJNR Am J Neuroradiol* 2006;27:1252–56.
2. Lalwani AK, Dowd CF, Halbach VV. **Grading venous restrictive disease in patients with dural arteriovenous fistulas of the transverse/sigmoid sinus.** *J Neurosurg* 1993;79:11–15

M. Wintermark and W.P. Dillon
Department of Radiology, Neuroradiology Section
University of California
San Francisco, Calif.