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{What's New in Neuro-Ophthalmology?}

{08.06.2015}

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What's New in Imaging?

Jonathan D. Trobe, MD
Professor of Ophthalmology and Neurology
University of Michigan
Ann Arbor, Michigan, USA

Technical improvements in neuroimaging in the past decade have allowed faster scan times and better resolution of lesions. Multi-detector CT has given rise to excellent vascular imaging, including the ability to visualize changes in perfusion over time—and all in under 5 minutes! Higher field strength MRI magnets are allowing finer resolution. MRI tractography permits visualization of white matter tracts. Diffusion-weighted MRI detects stroke within hours of onset. MR spectroscopy permits analysis of the chemical constituents of a lesion. Positron emission tomography (PET) and single-photon emission computerized tomography (SPECT), which measure alterations in metabolism based on radioisotopic detectors, are becoming more widely used in the hunt for lesions that do not show up on conventional structural scans. Functional MRI (fMRI), which depends on changes in blood flow in areas of brain activation, is still largely a research tool.

As important as these developments are, the real issue is that ophthalmologists are not getting the best use out of available imaging methods. Why not? Because we are sometimes failing to use widely available scanning sequences, scanning the wrong part of the body, using the wrong imaging technique, or not directing the radiologist's attention to the "region of interest" or the "lesion of interest." We must also be aware that there are limits to the diagnostic utility of imaging. That is, many lesions CANNOT BE IMAGED even with the best of techniques, many different lesions will have the same imaging characteristics, and radiologists will make mistakes—just as we do! In this short lecture, I will give you examples.

1. Failure To Use Available Sequences

Most commonly, this error occurs when diffusion-weighted imaging (DWI) is not used. DWI measures diffusion of water molecules within brain extracellular space. Restricted diffusion occurs when cells swell suddenly after infarction or when tightly-packed tumors or abscesses compromise that extracellular space. DWI is most useful for ophthalmologists in distinguishing occipital infarction from posterior reversible encephalopathy syndrome (PRES), which does not restrict diffusion. DWI is also useful in detecting lymphoma, which is densely cellular, and has been used to detect retinal abscess and thrombosis of the superior ophthalmic vein.

The other sequence of great value is gradient echo imaging (GRE), which is especially sensitive to extravascular blood products. GRE is useful in detecting cavernous malformations and diffuse axonal injury in patients with closed head injury.

In the past, the most common mistake was the failure to use contrast. That problem still exists, but it is less prevalent. If you do not get contrast, the imaging fail to disclose a lesion that is otherwise isointense to surrounding structures. Also, you will fail to see whether the blood-brain-barrier is intact or whether the lesion has an increased blood supply.

Another mistake is failure to get MRI "fat suppression." If you do not suppress the natural orbital fat, you cannot see the optic nerve properly or whether it enhances with contrast.

2. Scanning The Wrong Part Of The Body

This mistake most often occurs when the brain is scanned but not the orbit. Strangely, the orbit is not adequately visualized in conventional brain CT or MRI scans! I will show you an example of a patient with diplopia from restrictive myopathy in Graves disease whose diagnosis was missed on a brain scan.

A second area of concern is the imaging of acute isolated Horner syndrome. Most often the lesion is a dissection in the cervical carotid artery. That lesion can be visualized either with CT or MR angiography (CTA is faster and more reliable than MRI), but the neck must be selected for imaging, not the head or the chest, as is too often done!

3. Using The Wrong Imaging Technique

Should you use CT or MRI? CT is good for blood and bones and for detecting most foreign bodies. It is quite good in the orbit because of the natural contrast between the low x-ray attenuation of fat and the higher attenuation of the other orbital structures. Non-contrast CT is the first modality used for all head conditions in the emergency room because it can detect fractures, blood, and large shifts in brain tissue. But otherwise MRI is the way to go for all intracranial disease and for most orbital disease!

A major area of controversy is the proper selection of vascular imaging techniques. CT angiography is now widely recommended over MRA for detecting aneurysms, dissections, malformations, and venous sinus thrombosis. Catheter digital angiography is necessary to detect arteriovenous fistulas, including those affecting the cavernous sinus. It is also necessary to define the vascular anatomy of most intracranial vascular lesions before embarking on treatment.

4. Not Directing The Radiologist's Attention

This problem comes up when causative lesions are small. MRI scans are more complicated than CT scans. If radiologists do not know where to look, they may miss the abnormalities. I will show you at least one example.

5. Not Realizing That Imaging Has Its Limits

Some lesions simply do not show up on imaging. Examples are non-arteritic ischemic optic neuropathy and papillitis. Even though they may cause dramatic optic disc swelling and devastating vision loss, the lesions are limited to the prelaminar optic nerve. Nothing is seen on the highest resolution MRI. That fact may be diagnostically helpful, in that retrolaminar optic neuropathies usually do show abnormalities on MRI.

Most MRI lesions are visualized because they cause an increase in free water (high signal on T2 and FLAIR). Many lesions do this. For example, multiple sclerosis and microvascular ischemia both cause scattered white matter high signal spots. Yet their pathogenesis and management are vastly different.

MRI enhancement merely reflects a breakdown in the blood-brain barrier. Optic nerve sheath meningiomas and dural inflammation can both cause this phenomenon, yet their pathogenesis and management are vastly different. Watch out!

6. Not Realizing That Radiologists Make Mistakes

Of course they do. But most especially if they have had limited training in detection of certain lesions.

Of great importance to ophthalmologists in the issue of aneurysm detection, particularly in patients with isolated unilateral third nerve palsy. Neuro-ophthalmologists will share with you their anecdotes of patients who were misdiagnosed as having microvascular ischemia or inflammation as the cause of third nerve palsy until expert review disclosed the aneurysm. Delayed diagnosis of intracranial aneurysm carries a high risk of rupture with a 50% mortality!