Editorial Comment

Funeral for a Friend

This editorial is not written by Elton John, and the funeral is not for Marilyn Monroe. We are neuroradiologists, and it is probably time to say farewell to diagnostic digital subtraction angiography (DSA) in patients with carotid artery stenosis.

Moniz,¹ a Portuguese neurologist, brought cerebral angiography to life in 1927, and since then, techniques have improved continuously up to ultrasoft catheters and high-resolution biplane angiography equipment. However, despite all these improvements, it is still risky to inject a contrast agent into the cerebral circulation.² We all are hopeful that visualization of supra-aortal vessels might be possible some day without any risk to the patient.

Ultrasound with its variants was a major step forward toward noninvasive imaging of the carotid bifurcation.³ ⁴ Depending on the person who did the examination, it became a perfect screening tool and replaced DSA for presurgical workup in those institutions in which experienced “ultrasound” and vascular surgeons had the opportunity to work and learn together. However, it is highly observer dependent, and DSA remained the gold standard. As a consequence, we all perform many diagnostic angiographies in patients with internal carotid artery (ICA) stenosis who had at least 1 Doppler ultrasound examination previously.

In 1985, a Science article by Wedeen and colleagues⁵ established the next milestone: Projective imaging of pulsatile flow was possible with MR, and it works without contrast agent injection. At that time, image quality was bad; temporal and spatial resolution was far beyond from being satisfactory. But since then, MR angiography (MRA) became an ultrafast, high-resolution imaging method. It still works without contrast agent injection (time-of-flight technique), but the faster variant is based on intravenous bolus injection of a paramagnetic agent. With the latter technique, supra-aortal vessels from the aortic arch to the circle of Willis can be visualized in a 10-second shot. Despite these fantastic technical possibilities, there is ongoing debate about the diagnostic power of MRA, and in many institutions, MRA is used as an add-on tool. During the first years of MRA, we all had a tendency to overestimate the degree of stenosis, but after a while, we learned to look at the images the right way. However, many scientific articles dealt with this overestimation problem, and neurologists and vascular surgeons, despite increasingly enjoying the image quality, had remaining doubts about the diagnostic power.

In the current issue of Stroke, Nederkoorn and his team present an excellent meta-analysis comparing MRA, duplex ultrasound (DUS), and DSA. In total, 62 articles were analyzed. MRA had a pooled sensitivity and specificity of 95% and 90% in detecting severe ICA stenosis. The discriminating power of MRA for the distinction of <70% versus 70% to 99% stenosis was significantly better than the power of DUS. Most MRA studies were based on non–contrast-enhanced techniques, but overall, the authors did not find a significant difference in diagnostic power between different MRA techniques. It was the same group that recently found that the mean difference between stenoses at MRA and DSA in corresponding projections was 0.4% (95% confidence interval, −2.0 to 2.7). If corresponding MRA and intraarterial DSA projections are compared, 3-dimensional time-of-flight MRA does not overestimate carotid stenosis.⁶

What is the conclusion? The authors are pretty cautious and state only that MRA has better discriminatory power than DUS in recognizing 70% to 99% stenosis and is a sensitive and specific test compared with DSA in the evaluation of carotid artery stenosis.

From a clinical point of view (and this is our interpretation), this could be translated as the following: We do not need diagnostic DSA in patients with carotid artery stenosis. DUS is already excellent; MRA is better. If MRA and DUS really leave anything open, CT angiography, specifically if multirow CT machines are available, is another excellent minimally invasive tool to visualize vessel pathology. Another future gimmick of MR imaging will become “plaque imaging” and with high-resolution techniques, which might give us totally new insights into the pathology of the vessel wall and the clinical impact of different types of ICA bifurcational disease. There will always be patients with contraindications to MRI, previously stented patients and probably some rare clinical situations (occlusion of ICA with ongoing ipsilateral transient ischemic attacks), that will allow us to do a DSA. Long et al⁷ just reported that in France >60% of carotid endarterectomies are still based on DUS and DSA findings. Lack of access to MRA is the limiting factor. And this may be another circumstance justifying DSA in these patients.

However, for those who like to be part of the angio suite, it is much too early to retire. Interventional neuroradiology is growing rapidly. The International Subarachnoid Aneurysm Trial Collaborative Group just figured out that endovascular therapy of ruptured intracranial aneurysms is better than clipping in terms of patient outcome.⁸ Single-center experiences suggest that stenting of ICA stenosis might be at least equal to surgery. Currently, a couple of studies on the way are attempting to randomize patients into an endovascular and a surgical treatment arm. What will become more difficult is training people if they are not allowed to do diagnostic angiographies any more. But we have to manage this training problem the way that Nederkoorn and his colleagues man-
aged to figure out what the right answer to an important question is. And they did a good job.

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