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LETTER

Role of Catheter Angiography in Diagnostic Neuroradiology

I read with interest the article "Neurological Complications of Cerebral Angiography," by J. E. Heiserman and colleagues, published in the September issue of *AJNR*. The article focuses on a crucial problem, but I feel that some points are not correctly approached. Even in T. O. Gabrielsen's excellent commentary, the following points are not adequately stressed. The authors write:

1. "Biplane magnification cut-film angiography was the primary imaging modality . . ." and "The advent of digital subtraction angiography has added a powerful new imaging tool . . . however, modern digital subtraction angiographic systems achieve considerably less spatial resolution . . ." Nowadays these limitations of digital subtraction angiography have been overcome. The new matrices go up to 1024×1024 ; the contrast resolution compensates the possible limitation in spatial resolution very well. Moreover, such spatial resolution seldom is required in clinical practice and certainly not needed for the majority of the cases described in the article's series. The quality of digital subtraction angiography make it the method of choice, particularly when a high level of patient safety is needed, as in the case of elderly atherosclerotic patients.
2. "Standard injection rates . . . vertebral artery, 8 milliliters per second/12 milliliters total volume . . ." It is, I think, a logical conclusion that the majority of adverse events were observed in the case of vertebral artery injections. In my experience with digital subtraction angiography since 1982, the amount of contrast medium sufficient for vertebral injections is limited to 2 mL/s and 4 mL total volume of iopamidol 150. In total iodine content, it is a dose roughly six times smaller than the dose used by the authors. If the study is performed by means of a biplanar system, the dose is 12 times smaller.

The experience I refer to is not a special one, it is routine in any neuroradiologic department in Italy. When dealing with "complications," the best standard of reference should be used; otherwise it would be better to write "the complications in our experience" or "our complications."

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Reply

We appreciate Professor Leonardi's comments and interest in our work. Modern digital subtraction angiography (DSA) has achieved impressive spatial resolution, but it

still falls short of the approximately 4000 lines achievable in each dimension with magnification film-screen methods. We do not consider contrast resolution to be a substitute for spatial resolution; however, we agree that this strength of DSA makes it a valuable technique that we frequently use. We are not aware of any studies documenting the lack of benefit of the superior spatial resolution of film-screen methods compared with DSA in clinical practice. In our own anecdotal experience, there is an obvious difference in edge definition between film-screen images and DSA when they are compared at the same magnification. We also have seen cases in which a small aneurysm is much better defined on film-screen studies than on DSA. We are not prepared to discount the clinical importance of an incidentally discovered cerebral aneurysm of any size.

Our standard vertebral artery injection for film-screen imaging is 8 mL/s and 10 mL total volume, as described in the "Methods" section of our paper. This results in reflux of the contralateral vertebral artery for visualization of the origin of the posterior inferior cerebellar artery. Of the five persistent complications in our series, none was temporally related to a vertebral artery injection. One of these events, a unilateral facial paresis, could conceivably have been attributable to posterior circulation ischemia, but the deficit occurred about 1 hour after angiography. Of the five transient deficits, two occurred 5 minutes after selective injection of the left vertebral artery. As it happens, one other transient event occurred 1 minute after injection of the left subclavian artery for DSA imaging of the posterior fossa. Thus, most of the adverse events were not associated with vertebral artery injections. We feel that neurologic complications are associated more closely with catheter manipulation in patients with atherosclerosis than with the dose of contrast agent.

As with all trials dealing with complications of angiography, care must be taken in generalizing our results. However, it is useful to note that several recent large prospective trials using varying radiographic methods and contrast protocols have arrived at statistically similar complication rates, confirming the safety of this important diagnostic procedure when it is performed with meticulous technique.

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Editor's Note.—The letter from Professor Leonardi was forwarded to Dr Charles Strother for additional comments, which follow.

Comment

During the 25 years since I performed my first angiographic procedure (a direct carotid puncture), it has been my good fortune to learn angiographic technique and diagnosis under the guidance of several master angiographers (Marshall, Newton, Zatz) and also to have had the opportunity to participate directly in the clinical development of nonionic contrast media and digital subtraction angiographic techniques. During the second half of this interval, my activities have been almost exclusively devoted to interventional neuroradiology. These experiences form the basis for my views regarding angiographers and angiographic techniques. I would offer several comments based on these experiences.

First, film-screen techniques for diagnostic angiography fall into the category of an endangered species and, in the modern neuroradiology angiography suite at least, will soon become extinct. Appropriate usage of computed tomography and magnetic resonance imaging make any "theoretical" diagnostic advantages that film-screen techniques may have over digital methods of at best dubious significance; film-screen methods play no role in the performance of interventional neuroradiology procedures. Although prospective studies may fail to show clear advantages of digital over film-screen techniques, experience certainly shows practical advantages of the digital methods. These include marked improvements in contrast medium load, procedure time, and image manipulation and storage when digital angiography is used in replacement of film-screen methods.

Second, except for evaluation of patients with vascular disease, catheter angiography is seldom required. Even in the broad category of central nervous system vascular disease, several conditions can now usually be definitively evaluated before surgery using combinations of magnetic resonance imaging, magnetic resonance angiography, and ultrasound (ie, extracranial vascular disease). Because these techniques are without the risk of neurologic

injury, they should be substituted, whenever possible, either alone or in appropriate combination for catheter angiography. It is the responsibility of the neuroradiologist not only to provide accurate diagnosis but also to demand that this be achieved using techniques that offer the lowest risk and least discomfort to the patient. Those situations in which catheter angiography is required for either diagnosis or preoperative planning are rapidly diminishing. Further development and dissemination of three-dimensional computed tomography, magnetic resonance angiography, and ultrasound will, in the foreseeable future, cause catheter angiography to become a technique seldom done except in association with therapeutic endovascular procedures.

Third, in many departments, it is increasingly difficult or impossible to provide trainees as well as staff adequate experience in catheter angiography. Certainly, from the patients perspective, there can be little justification for performance of an angiographic examination by individuals having either inadequate or "rusty" techniques. Again, although formal studies may show no correlation of angiographic complications with experience of the angiographers, all of us know that experience does count, and few practitioners would agree to having a catheter manipulated in the arteries feeding their brain by someone with either inadequate training or outdated experience.

Finally, as catheter angiography passes through the last stages of its evolution from a purely diagnostic technique providing superb definition of the arteries and veins of the central nervous system to a key component in the armamentarium used for the treatment of vascular disease, it will become increasingly important for neuroradiologists to ensure that the technique is used safely and appropriately. With appropriate attentiveness, sensitivity, and creativity, this can be achieved while ensuring accurate diagnosis and simultaneously minimizing the anxiety felt by trainees and colleagues alike.

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