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Editorial

Digital Subtraction Intravenous Angiography

The idea of using intravenously injected radiopaque contrast media to perform arteriography has occurred to many investigators over the past several decades because of its potential to demonstrate arterial anatomy in a relatively noninvasive manner. However, attempts to use this approach for angiography have been only partially successful until very recently. In 1938, Robb and Steinberg [1, 2] were the first to propose and carry out intravenous angiocardiography. This approach was relatively successful but became obsolete after introduction of direct injection into the cardiac chambers by means of catheters.

Evans and Poker [3] deserve credit for the development of nephrotomography. In some of their original publications the arterial phase was recorded by means of tomographic cuts taken at the level of the aorta and renal arteries. This was certainly one of the early attempts to perform arteriography of more distal arteries by intravenous methods. The procedure, which required timing of the circulation, was often unsuccessful and mostly abandoned as nephrotomography became an accepted procedure and catheter angiography became widespread.

In the mid-1950s, the possibility of visualizing the extracranial parts of the carotid and vertebral arteries by intravenous angiography was demonstrated by Viallet et al. [4–6]. At the time, almost all cerebral angiography was carried out by direct puncture of the carotid and vertebral arteries and an intravenous approach was highly welcomed. However, it was clear that the visualization of the vessels was at best marginal and it was eventually given up in favor of the catheterization procedures which were slowly gaining in popularity.

After the initial trials of intravenous cerebral angiography in the late 50s and early 60s, there was a dormant period of well over a decade. However, in the last few years some investigators in North America and Europe have begun using intravenous methods for visualizing the extracranial vessels; a few papers reporting their experience were presented at the last meeting of the American Society of Neuroradiology in March 1980 [7, 8].

At the annual meeting of the American Society of Neuroradiology (ASNR) in Toronto, Canada in May 1979, Christenson and his associates demonstrated the feasibility of using digital subtraction techniques to obtain excellent images of the extracranial vessels after intravenous injection of a bolus of radiopaque contrast substance. This constitutes a truly revolutionary step and it is obvious from the description of the technique found in this issue (pages 387–390) that much research had to precede the successful acquisition of satisfactory images. At the 1980 ASNR meeting, two other papers dealing with this technique were presented [9, 10]. A third presentation dealt with the use of computed tomography (CT) to obtain transverse images of the carotid arteries after intravenous contrast injection [11], which represents yet another way to noninvasively image the carotid arteries.

After a period of several decades when progressively *more invasive* procedures were introduced in neuroradiology to visualize the brain and its vascular anatomy and physiology, we now find ourselves seriously engaged in an effort to develop and use progressively *less invasive* approaches. The development of CT was a true milestone in this respect. Intravenous angiography may well replace catheter angiography to diagnose certain conditions, particularly of the extracranial vessels, and in time it may be used to study intracranial pathology as well. The latter will require considerable refinement in this new technique because of the superimposition of the right and left sides and, in order to visualize the vessels in the lateral projection, it will be necessary to develop stereoscopic techniques.

With the current interest in the study of atherosclerotic lesions of the extracranial vessels, which has led to the recent strong development of noninvasive approaches such as Doppler sonography in the periorbital region, ocular plethysmography, thermography, direct carotid imaging with B-mode sonography, and various forms of phonetic study of bruits in the carotid system, I have no doubt that the development of digital subtraction intravenous angiography is a real "breakthrough" and promises to have application

not only in the carotid and vertebral systems but also in other areas of the body such as the aorta or the renal vessels. In order to obtain the necessary refinements, considerable computer capacity will be required, but if history is an example, we can expect that this will be developed fairly rapidly at a reasonable cost. Several manufacturers are now working in this area and we hope that apparatus will be available for this purpose within the next 8–12 months. At that time, I expect that the direct radiographic approach for intravenous angiography will be replaced by the new method of digital subtraction.

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