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Allan J. Fox

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Technical Aspects of Neuroangiography: Are Risks and Safeguards Understood in the Same Way?

Details of technical safeguards for neuroangiography are seldom discussed at regional or national neuroradiology meetings. Even discussion among peers about the real risks involved are rare. It is as if neuroangiographers learned what there was to know from their mentors, made whatever adjustments they believed valuable early in their careers, and never again reconsidered changes in technique and safety. The article by Yousem and Trinh (page 1838) on the results of a survey of the angiographic injection rates for cerebral angiography, which appears in this issue, is a welcome opening and change.

Yousem and Trinh have questioned the rates and volumes of contrast material injection into the cervical portions of carotid or vertebral arteries for angiographic examination of acute subarachnoid hemorrhage. They were stimulated by the small number of case reports in the recent literature about aneurysm rupture during angiographic injection. Their survey revealed that substantial amounts of contrast material are being injected and that the respondents were confident that the rates used were not important in regard to the risks of active complications.

The literature and experience clearly show that the risk of aneurysm rerupture during angiography is trivial. Having practiced neuroradiology, including active neuroangiography, at the well-known aneurysm center in London, Ontario, Canada, for more than 24 y, I experienced only two occasions of aneurysm rupture during angiography, both fatal, among thousands of cases of subarachnoid hemorrhage involving angiography. Aneurysms are known to have a serious spontaneous rebleeding rate during the first days after hemorrhage. This high risk of rebleeding guides much of the aggressive treatment for aneurysms to protect against the next episode of bleed. If only two ruptures occurred during angiography in thousands of such cases, the real question to ask is, "Why are there so few cases of rebleeding during angiography?" The spontaneous aneurysm rebleeding rates that are well documented for ruptured aneurysms should have coincidentally caused many more cases of bleeding during angiography than the very few observed.

The multidecade-long practice of neuroangiography in London, Ontario, for subarachnoid hemorrhage has included the injection of healthy volumes of contrast material, always with a mechanical pump, and residents, fellows, and neuroradiologists have been the prime operators. The overall angiographic risk was described in a prospective clinical trial performed in the mid-1980s (1), and it has changed little since that time. For 2

decades, 3000 U of heparin per 500 mL of normal saline has been used for flushing by means of a syringe and for constant infusion, even in patients with acute subarachnoid hemorrhage. Since the change to universal digital angiography, the non-ionic contrast material now used is diluted to a 50:50 or 33:67 ratio of heparin and saline mixed with contrast material. Rates of injection of diluted contrast material have always been higher than the mean of the results of Yousem and Trinh, namely, 10 mL/s for a total of 12 mL in the common carotid injections, 6–7 mL/s for a total of 9–10 mL in the internal carotid injections, and 6–7 mL/s for a total of 9 mL in vertebral injections. Those who inject smaller volumes might consider this approach aggressive. The goal is to enable thorough angiography, opening up all potential "nooks and crannies," in the search for aneurysms.

Actually, a natural protection for the pressure wave of the injection discussed by Yousem and Trinh exists. With injection into the common carotid or internal carotid artery, as normally performed, most of the highest pressure is dissipated downward toward the more proximal vessel. The slight extra pressure that goes upward adds some transient cross-filling of the anterior and posterior communicating arteries, which is desirable as an aid to thorough angiographic demonstration of aneurysms. Certainly, an incidence of missed aneurysms caused by inadequate angiography exists when cross-filling is not achieved, and manual compression of the carotid artery to induce cross-filling adds potential risk, as well as extra radiation exposure of the angiographer who does it.

Producing a pressure wave from the force of injection that is dangerously transmitted into the aneurysm is still a possibility; it is one of the risks for which safeguards during angiography are constantly needed. The potential that an injection of contrast material could cause an aneurysm rupture is enhanced by the placement of an angiographic catheter in a position where it may stimulate arterial wall spasm at the level of the catheter tip. Catheter spasm can effectively occlude the artery and then transmit any excess pressure upward during injection, because the artery effectively becomes a temporarily closed system. This situation must be actively avoided by using multiple simple technical tricks: 1) Place the curve of the catheter tip within a natural curve of the internal or vertebral artery; 2) withdraw all potential slack of the catheter in the aorta before beginning the injection; and 3) when performing a small check injection with fluoroscopy, observe the prompt dilution of the contrast material flowing upward from the catheter tip.

When any concern exists, the catheter should be slowly and slightly pulled down to reverse the arrest of flow around the catheter tip. With such safeguards, catheter spasm rarely occurs. Without catheter spasm, the risk an injection of contrast material causing aneurysm rupture is small.

Many more little "tricks" to keep neuroangiography safe exist, and more frequent informal discussions between angiographers could stimulate sharing of these ideas. Clearly, safe angiography is currently performed in the neuroradiology community, as evidenced by the few ruptured aneurysms reported during angiography. Likely the mentioned safety tricks, or alternatives, are commonly used. More surveys of how neuroangiogra-

phers avoid serious trouble would provide a continuing forum in which neuroangiographers can share their experiences, so that those with more complications in their practice might glean new additional safeguards to use in their patients.

ALLAN J. FOX MD
Member, Editorial Board

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