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Delayed Ischemia Due to Cerebral Vasospasm Occult to Transcranial Doppler An Important Role for Cerebral Perfusion SPECT

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Abstract

Cerebral vasospasm after subarachnoid hemorrhage is very common, but it is not universally detectable by transcranial Doppler. SPECT imaging of regional cerebral blood flow with Tc-99m exametazime serves as a complementary test to transcranial Doppler in the evaluation of patients at high risk for vasospasm. The significance of vasospasm, which may be underestimated by TCD, is readily identified with SPECT cerebral perfusion imaging.

THE IMPACT OF the surveillance and treatment of cerebral vasospasm after subarachnoid hemorrhage has resulted in improved patient outcomes (1). The noninvasive detection of vasospasm has relied on the ability of transcranial Doppler (TCD) ultrasound to detect yascular narrowing in the branches of the Circle of Willis (2). Nevertheless, TCD may not detect vasospasm of distal vessels or in patients with poor bone "windows." To provide the much needed complementary test to TCD, single-photon emission computed tomography (SPECT) of regional cerebral blood flow is used to detect the tissue perfusion effects of the vascular narrowing in proximal or distal vessels, or the results of vasospasm in vessels that are difficult to insonate (3,4).

Case Report

A 49-year-old female had clipping of a left posterior communicating artery aneurysm that had caused subarachnoid hemorrhage. During the postoperative course, significant cerebral vasospasm was detected by TCD and SPECT associated with clinical neurologic deficits. The patient underwent balloon angioplasty of the left middle cerebral artery with resultant improvement in clinical symptoms, TCD and SPECT findings. Seven days later, the patient was noted to have developed recurrent obtundation. Transcranial Doppler recorded left middle cerebral artery (MCA)/extracranial internal carotid artery (ICA) velocity ratio of 3.33 and right MCA extracranial ICA velocity ratio of 2.43. Middle cerebral artery/ICA ratios above 6 are associated with significant vasospasm (5,6). The TCD sonographer recorded "moderate to severe" basilar artery vasospasm and "mild" vasospasm of the left ICA, MCA, anterior cerebral artery and bilateral posterior cerebral artery territories. A SPECT scan of cerebral perfusion performed with Tc-99m exametazime (HMPAO, Ceretec, Amersham/Medi-Physics, Arlington Heights, IL) on a PRISM 3000 triple headed scanner (Picker International, Ohio Imaging Division, Cleveland, OH) with low energy high-resolution parallel hole collimators showed severe new defects of perfusion in the right anterior cerebral artery territory and the left MCA territory compared to the previous SPECT scan of 4/24/95 (Fig. 1). Based on these findings, the patient was taken to the angiography suite where severe vasospasm involving the right first segment of anterior cerebral artery, distal left MCA (second segment of middle cerebral artery), and left posterior cerebral artery was found (Fig. 2). Due to the distal location of the vasospasm, each of the three territories was infused with 300 mg intra-arterial papaverine with resultant angiographic and clinical improvement (7).

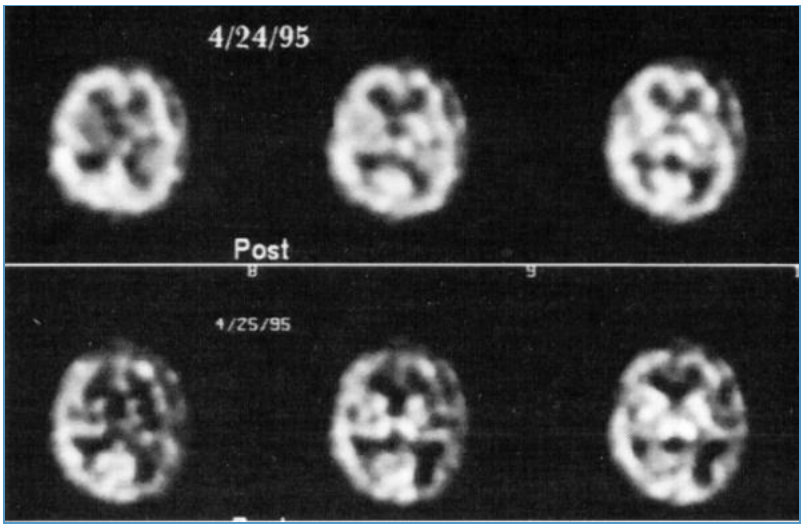

Fig. 1. Transverse axial Tc-99m HMPAO SPECT images on 4/24/95 (top) and 4/25/95 (bottom). Images show a change of blood flow of moderate to severe degree of hypoperfusion in the vascular territories of the left middle cerebral artery and right anterior cerebral artery.

Fig. 2. Right anterior-posterior internal carotid angiogram shows right first segment of anterior cerebral artery vasospasm (arrow).

Discussion

Patients with high risk of cerebral vasospasm because of subarachnoid hemorrhage are monitored frequently by neurologic examination and TCD to detect significant vascular narrowing. There is a need, however, for a complementary and/or confirmatory test of the effect of vasospasm on tissue perfusion. This test is particularly necessary in settings in which these tests are unrevealing or nonspecific and patients are of poor clinical grade and, therefore, may not manifest new changes on neurologic examination. Single photon emission computed tomography fulfills this role by showing the end-organ effects of the vasospasm in a timely manner as the above case has shown. The ease of use of the SPECT technique, which involves the intravenous injection of a Tc-99m radiopharmaceutical that distributes into neuronal tissue according to cerebral blood flow, remains fixed and reflects the blood flow at

the moment of time of injection has led to rapidly performed studies. At Harborview Medical Center (Seattle, WA), critically ill patients, who may be intubated with invasive monitoring devices in place and on intravenous hyperdynamic/hypertensive therapy, have SPECT scans that take about 20 minutes to perform. These scans provide immediate feedback to the attending neurosurgeons about the nature of the effects of vasospasm on regional blood flow. Patients then can be identified for aggressive medical or interventional therapy based on the scan results.

In most instances of cerebral vasospasm that leads to delayed ischemia, the results of TCD and SPECT correlate well with one another (8,9). However, as shown above, there are infrequent but important variances, such as distal vessel vasospasm, which may have an incidence rate of 7.5%,(2) in which the SPECT scan will provide unique information for patient management. Single emission positron emission computed tomography will show the hemodynamic significance of lesions, which may be occult to TCD.

Critically ill patients with subarachnoid hemorrhage may have multifactorial causes for decline in neurologic status after aneurysm clipping, including electrolyte imbalances, hydrocephalus, and other intercurrent medical diseases in addition to the extremely important factor of vasospasm. The combined use of TCD and SPECT has proved very useful in appropriately directing the care of ruptured aneurysm patients at our center (9). The SPECT scan performed within a day after clipping of the aneurysm serves the very important purpose of a baseline for comparison to later scans, which may indicate significant interval changes of regional cerebral perfusion due to vasospasm. The vascular insult may occur at nearly any location from large to small vessels of the intracranial cerebrovascular system. Expeditious treatment of the vasospasm should result in clinical improvement in most individuals (10-12)

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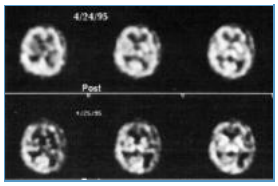

Fig. 1

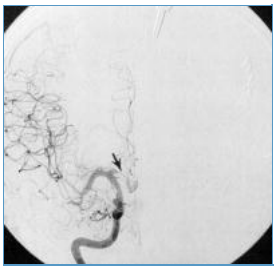

Fig. 2

Back to Top