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MR of CSF Flow Phenomenon Mimicking Basilar Artery Aneurysm

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CSF motion from transmitted vascular pulsations can result in focal areas of CSF hypointensity on MR images because of signal mismapping from phase shift. When this CSF flow void occurs adjacent to the basilar artery in the prepontine cistern, it may be mistaken for a basilar artery aneurysm on proton-density and T2-weighted spin-echo images. Head MR scans of 50 consecutive patients referred for various indications were reviewed, and this phenomenon was noted in the prepontine cistern in 38 patients. Fifteen of these images had an appearance mimicking an aneurysm. When doubt exists, dynamic high-resolution CT scans should be sufficient for clarification.

MR imaging has proven useful in evaluating cerebrovascular disease, including vascular occlusion and infarct, hemorrhage, arterial venous malformation, aneurysm, and cerebral blood flow. Familiarity with the variable appearance of flowing blood and with the concepts of flow-related enhancement, even-echo rephasing, and diastolic pseudogating is essential to avoid mistaking physiological phenomena for disease. Recently, areas of hypointensity within the ventricles and subarachnoid spaces secondary to CSF motion have been reported, but the clinical and diagnostic implications of this phenomenon have not been fully elucidated. A recent case in which CSF flow void was mistaken for a basilar artery aneurysm prompted this report.

Case Report

A six-year-old, otherwise healthy girl suffered two episodes of nausea, vomiting, dizziness, and confusion within a period of 1 year prior to examination. The clinical diagnosis was that of an atypical basilar artery migraine. Head MR scanning was performed with sagittal partial-saturation (TR = 600, TE = 30), and axial and coronal spin-echo sequences (TR = 2000, TE = 20, and TE = 70) were obtained. A round, focal 9-mm area of hypointensity was noted in the prepontine cistern on the axial and coronal proton-density and T2-weighted images that was suspected of being a basilar artery aneurysm (Fig. 1). The remainder of the study was normal. The sagittal partial-saturation images did not convincingly confirm or disprove the presence of an aneurysm. A dynamic coronal and axial high-resolution CT scan was then obtained, which clearly showed the basilar artery to be normal without evidence of aneurysm or other abnormality in the prepontine region (Figs. 1C and 1D). The patient's symptoms resolved during the follow-up.

Materials and Methods

The brain MR studies of 50 consecutive patients were retrospectively reviewed. Examinations were performed for a wide variety of indications, but predominantly for headaches, seizures, and multiple sclerosis. No scans were obtained for subarachnoid hemorrhage or to rule out aneurysm. There were 20 males and 30 females, ranging in age from 3 to 70.

MR images were obtained with a 1.5-T MR system (General Electric Signa). An initial sagittal partial-saturation localizer scan (TR = 600, TE = 30) was followed by an axial variable-

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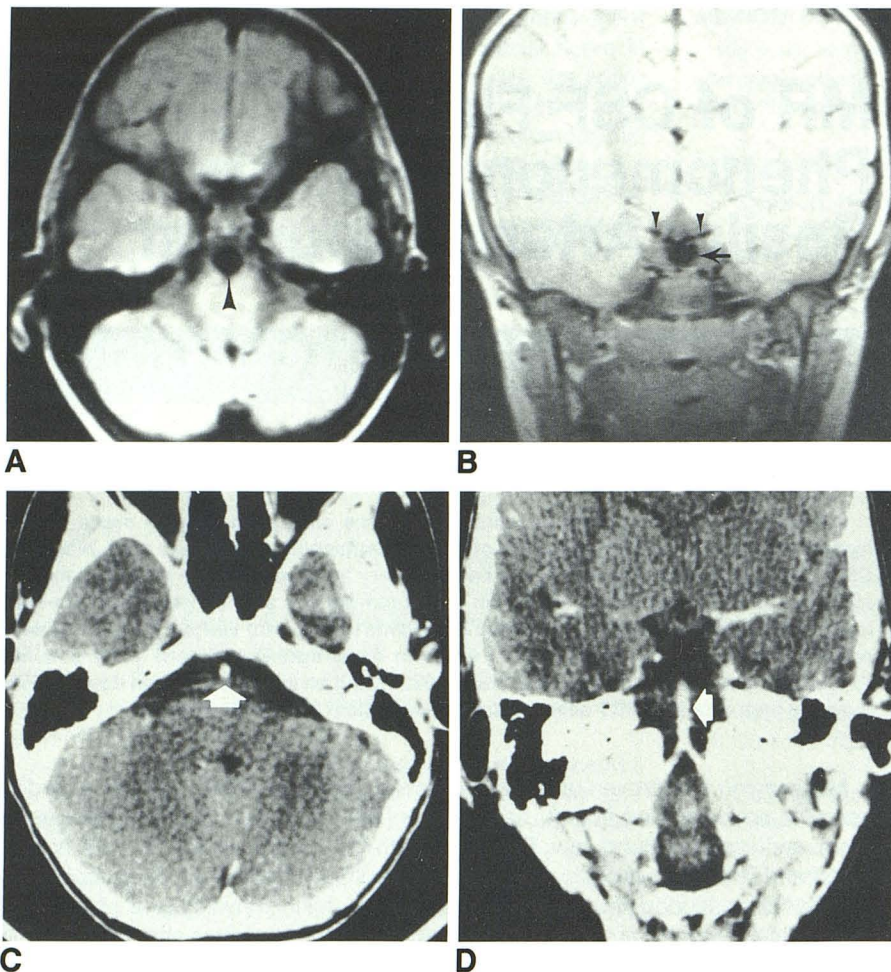


Fig. 1.—A, Axial spin-echo sequence (TR = 2000, TE = 20). Round, focal 9-mm area of hypointensity (arrowhead) in prepontine cistern mimics basilar artery aneurysm. Window setting adjusted to optimize cisternal visualization.

B, Coronal spin-echo sequence (TR = 2000, TE = 20). Hypointense area (arrow) surrounds midportion of basilar artery. Proximal portion (arrowheads) of posterior cerebral arteries is clearly shown.

C and D, Axial (C) and coronal (D) 3-mm CT slices through basilar artery (arrows) during enhanced dynamic bolus study. The basilar artery and prepontine cistern are normal.

echo, multiplanar spin-echo sequence (TR = 2000, TE = 20 and 70) in all patients. Spin-echo sequences were obtained with two signal acquisitions— 128×256 or 256×256 matrix—and 2DFT. Additional coronal and sagittal partial-saturation or spin-echo sequences were obtained in many patients, depending on findings in the screening exam. Comparison high-quality CT scans obtained on a General Electric 9800 CT scanner were available in nine patients with CSF flow phenomenon. Vertebral angiography was not performed.

Results

CSF flow phenomenon was recognized as an area of focally diminished signal adjacent to the basilar artery and was rated as mild, moderate, or marked (Fig. 2). Mild CSF flow phenomenon was identified as an ill-defined area of prepontine hypointensity relative to CSF in the other portion of the cisterns and ventricles. Moderate CSF flow phenomenon was better defined, usually being oval or round, but clearly distinguished from the basilar artery. In the instance of marked CSF flow void, the basilar artery was difficult to visualize within the area of artifactual focal hypointensity (on standard window settings) and mimicked a basilar artery aneurysm.

In 50 consecutive head MR scans, 38 showed CSF flow

phenomenon adjacent to the basilar artery. This was rated mild in 17, moderate in six, and marked (mimicking an aneurysm) in 15. Enhanced head CT scans were available in nine of the 38 patients with CSF flow phenomenon and all showed the basilar artery without evidence of aneurysm or other prepontine abnormality. In 15 patients with marked flow void, eight (53%) were younger than 13 years old and 12 (80%) were younger than 33 years old.

In all cases of CSF flow phenomenon, a prepontine hypointense area (compared with other ventricular and basilar cisternal CSF) was recognized on the first-echo (proton-density-weighted) image of the spin-echo sequence. The margins ranged from ill-defined to discrete and the shape was round or ovoid (particularly in the more pronounced cases). On the second-echo (T2-weighted) images, this area became relatively less hypointense and the basilar artery could be better separated from this artifactual area (Fig. 3). This separation could be accentuated by varying the window setting to a lower level of contrast. The CSF flow phenomenon was centered around the midportion of the basilar artery. The CSF adjacent to the junction of the vertebral arteries and the bifurcation of the basilar artery usually appeared similar to ventricular CSF without focal signal loss.

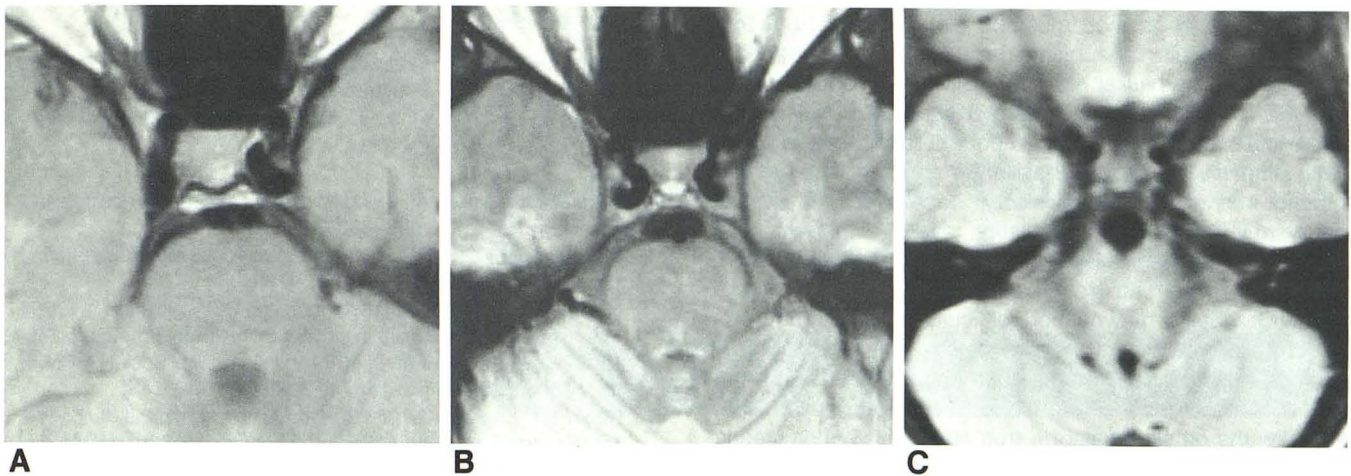


Fig. 2.—CSF flow phenomenon on axial proton-density weighted spin-echo images (TR = 2000, TE = 20). A, mild; B, moderate; and C, marked. Basilar artery is difficult to distinguish from marked CSF flow void (C).

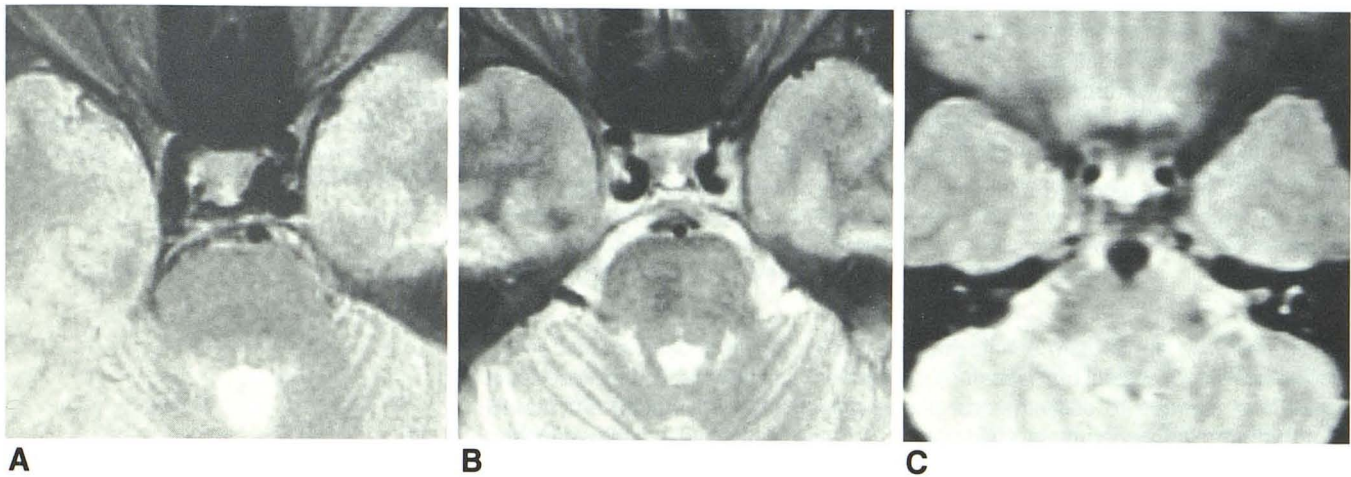


Fig. 3.—CSF flow phenomenon on axial T2-weighted images (TR = 2000, TE = 70). A, mild; B, moderate; and C, marked. Images are from same patients, respectively, as in Figure 2. Note that CSF motion artifact is less pronounced than on corresponding proton-density images.

Discussion

Recently, emphasis has been placed on the variable appearance of flowing blood on MR images. High velocity, turbulence, flow-related enhancement, even-echo rephasing, and diastolic pseudogating are factors influencing the variable appearance of flowing blood [1]. Paradoxically low signal intensity arising from the CSF spaces around the cervical and thoracic spine and within the ventricles has only recently been reported [2-4]. In Rubin's tubelike phantom model, pulsating water (CSF) appeared black instead of white and the signal from the water belonging in the tube (subarachnoid space) was mismapped outside the tube [3, 5]. This appearance on axial T2-weighted spin-echo images was thought to be the result of phase shift secondary to varying velocities of the

protons within the water as they pulsed within the tube under induced gradient fields. It was concluded that this model accounted for areas of low CSF signal intensity within the normal cervical and thoracic subarachnoid space.

In this series, a focal area of hypointensity was noted adjacent to the basilar artery on proton-density and T2-weighted images in 38 patients (76%). It is postulated that this appearance is secondary to CSF motion from transmitted arterial pulsations similar to low signal intensity described in other portions of the subarachnoid and intraventricular spaces [2-4]. In 15 patients (30%), this phenomenon was prominent enough to be confused with an aneurysm, particularly on the proton-density-weighted images. This finding is most frequent in younger people (53% were under 13). It may be that younger, pliable vessels transmit pulsations more easily than do the atherosclerotic, less elastic vessels of older individuals.

CSF flow phenomenon must be distinguished from true congenital saccular aneurysms or fusiform atherosclerotic aneurysms of the basilar artery. A helpful differential point is that CSF flow void usually appears most prominent near the midportion of the basilar artery in contrast to berry aneurysms, which primarily involve the basilar tip and the origin of the posterior-inferior cerebellar artery. Moreover, intracranial aneurysm in the pediatric population is rare, with fewer than 20 cases in children under age 5 reported in the literature [6]. Distinction from atherosclerotic aneurysm or vertebrobasilar dolichoectasia may be more difficult, particularly if thrombosed. Thrombus within the wall of an aneurysm generally becomes less intense on the second echo, in contrast to the relative increased intensity noted in CSF flow void [7]. Optimistically, the outside wall of a true aneurysm will be clearly evident, distinguishing it from the CSF flow phenomenon described in this report. Unfortunately, the MR appearance of true intracranial aneurysms has not been fully characterized, with only a single case report published in the literature [8]. When doubt exists, high-resolution dynamic CT scans through the basilar artery should be obtained. Owing to the frequent occurrence of CSF flow phenomenon and the inherent risk of conventional angiography, selective vertebral angiography is not warranted in these patients. If vascular studies are necessary, intravenous digital subtraction angiography (DSA) or nonselective intraarterial DSA examinations may be performed.

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