Magnetic Resonance Imaging of Acute SAH

To THE EDITOR: The article by Jenkins, et al., provokes two opposing comments (Jenkins A, Hadley DM, Teasdale GM, et al: Magnetic resonance imaging of acute subarachnoid hemorrhage. J Neurosurg 68: 731-736, May, 1988). It is very interesting to demonstrate the source of bleeding in cases of subarachnoid hemorrhage (SAH) with direct visualization, and to recognize the focal cerebral signal changes surrounding the aneurysm itself. This not only answers the old question about which aneurysm is causing the SAH in patients with multiple aneurysms, but more importantly it verifies whether a single aneurysm demonstrated with preoperative angiography is the source of bleeding.

According to the authors, magnetic resonance (MR) imaging is more accurate than computerized tomography scanning in detecting the diagnostic features described above. They state that this aspect is "the most striking difference" between the two diagnostic procedures. I would like to ask the authors why MR imaging did not reveal the source of hemorrhage and the focal cerebral changes in all of the cases examined? I think that MR imaging makes it easier to detect the cerebral perianeurysmal lesions than the source of bleeding. What about the diameter, direction of growth, and shape of aneurysms seen with MR imaging? Despite the results they presented, the photographs given as examples are not convincing enough, and Fig. 3 certainly is not correct: this is not an intracerebral hematoma caused by rupture of a middle cerebral artery (MCA) aneurysm, but instead represents a typical spontaneous or hypertensive gangliobasal hematoma. Probably the patient had an ipsilateral MCA aneurysm, but showing it without a cerebral surrounding area of lesion would increase the possibility of a correct diagnosis.

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RESPONSE: I thank Dr. Volpin for his interest in our paper and note his concern that we did not demonstrate local cerebral changes or focal perianeurysmal subarachnoid clot in all patients with a proven ruptured aneurysm. We were able to show a signal-void area representing an aneurysm in 14 of 25 patients with angiographic evidence of aneurysms and cerebral changes or focal cerebrospinal fluid (CSF) hematomas in 16 of the 25 patients. Cerebral parenchymal changes will not occur when the rupture is purely subarachnoid and small and does not directly involve the brain. In these cases it may only result in diffuse CSF staining. This occurred in six cases where signal changes, which we propose represent acute subarachnoid hemorrhage (SAH), were seen only in the preponente cistern. In three patients these changes were so widespread (in both sylvian fissures, the interhemispheric fissure, and basal cisterns) that localization of the offending aneurysm was impossible.

We agree that there is a limit to the size and type of aneurysm that can be directly shown by magnetic resonance imaging. This is due to partial volume effects coupled with flow artifacts in CSF and adjacent vessels. Care must also be taken not to "overdiagnose" aneurysms close to vessels that show apparent dilatations, which may in reality be due to divisions or tortuosity. To a certain extent, this can be excluded with additional sections taken in an orthogonal plane. The diameter, shape, and direction of growth, at least of moderate-sized aneurysms, are certainly well shown, and Fig. 4 in our paper demonstrates this even when the images were obtained with our rather dated low-field resistive magnet and a slice thickness of 8 mm. If volume imaging (three-dimensional Fourier transformation) or two-dimensional state-of-the-art high-field magnets with a 1- to 2-mm slice thickness were used, much smaller lesions could be characterized.

Our interpretation of Fig. 3 is criticized, but I suspect Fig. 2 is actually the illustration in question since Fig. 3 is a postoperative examination. Although this lesion has the morphology of a routine basal ganglion hematoma unassociated with an aneurysm, the patient was a 40-year-old man with no history of hypertension, and angiography revealed an aneurysm at the middle cerebral artery trifurcation pointing into the hematoma. At surgery it was thought to have ruptured. We believe it is too much of a coincidence for a hematoma associated with an aneurysm found to be ruptured at operation to be an incidental basal ganglia hematoma due to hypertension in a patient who had no risk factors for a hypertensive hemorrhage.

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Endothelium and Cerebral Vasospasm

To THE EDITOR: The review of the literature and the elegant experiments performed by Nakagomi, et al., on canine and rabbit cerebral arteries clearly support the hypothesis that damage to the endothelium that occurs following subarachnoid hemorrhage (SAH) would contribute to the pathogenesis of delayed cerebral vasospasm (Nakagomi T, Kassell NF, Sasaki T, et al: Effect of removal of the endothelium on vasoconstriction in canine and rabbit basilar arteries. J Neurosurg 68: 757-766, May, 1988). Their findings also provide a more realistic assessment of the special role that the endothelium-derived relaxing factor (EDRF) may play in maintaining cerebral blood flow. However, prostacyclin (prostaglandin I2) is also produced by the endothelium, is a potent dilator of cerebral arteries, and has a half-life in physiological buffer of about 3 minutes, some four to 30 times longer than that of EDRF. The same hypothesis was previously proposed for prostacyclin as it is today for EDRF: that a deficiency due to endothelial damage favored vasospasm. The report
that prostacyclin administered intra-arterially (as replacement therapy) failed to reverse cerebral vasospasm in canine models of SAH\(^4\) raises the question whether any factor manufactured by the endothelium would significantly alter the constriction caused by the presence of subarachnoid blood. Also, EDRF is said to be nitric oxide,\(^2\) and compounds that operate through a similar mechanism (elevating cyclic nucleotides) fail to reverse cerebral vasospasm.\(^8,16\)

It has also been proposed that hemoglobin causes cerebral vasospasm because it is a selective inhibitor of EDRF.\(^5,6\) However, hemoglobin is a very weak constrictor of human cerebral arteries in vitro\(^5\) and is a poor constrictor of cerebral arteries of the baboon in vivo.\(^1\)

It constrains canine cerebral arteries equally well in the presence or absence of the endothelium, it is not the vasoactive agent found in the cerebrospinal fluid of SAH patients,\(^13\) and it would fail as an inhibitor of EDRF in patients whose endothelium was functionally destroyed as a result of SAH.

Among other substances, vascular endothelium synthesizes the vasorelaxants antithrombin III, prostacyclin, and EDRF, and even an endothelium-derived contracting factor that is released from canine basilar arteries.\(^5\) The fact that thrombin releases both EDRF and prostacyclin illustrates further the problem of identifying which endothelial factors may be the most important physiologically. Moreover, experiments performed on isolated human cerebral arteries indicate that endothelium-dependent vasorelaxation is not normally sustained for prolonged periods as required of substances which could delay vasospasm.\(^11\) New knowledge of endothelial cells has undoubtedly enhanced the chance that rational therapies of certain vascular pathologies will be forthcoming, but the vasospasm of SAH involves much more than the endothelium.\(^5,8,10,12,14\)

Endothelium-derived relaxing factor may be one of many factors that help protect cerebral vessels from undue constriction\(^12\) but, as Nakagomi, et al., have so aptly demonstrated, destruction of the endothelium does not "per se" cause constriction of cerebral arteries.

The most salient feature of endothelial destruction apropos of spasm is that the constrictor response to many agonists is enhanced.\(^13\) However, the concept that cerebral vasospasm is the result of EDRF inhibition or endothelial damage should be put in perspective.

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References
3. Defeudis FV: New studies with EDRF and hemoglobin
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RESPONSE: Cerebral vasospasm is probably initiated by vasoactive substances released from the subarachnoid clot. A large number of putative spasmogens have been discussed but not one has been proved to be the cause of the delayed arterial narrowing.\(^2\) We hypothesized that there might be supplementary mechanisms that augment the role of vasoactive substances from the subarachnoid clot, and directed our attention to the role of endothelial injury to the major cerebral arteries in the pathogenesis of vasospasm.

Vascular endothelium synthesizes the vasorelaxants such as prostacyclin, endothelium-derived relaxing factor (EDRF), and antithrombin III. Subarachnoid hemorrhage (SAH) produces endothelial injury in the major cerebral arteries. Therefore, production of vasorelax-
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Ants in the endothelium may be impaired following SAH. Like Sasaki, et al., and Maeda, et al., we have demonstrated in our current paper and in an earlier one that endothelium-dependent vasodilatation in the major cerebral arteries was impaired following SAH, and that endothelium removal elevated the dose-response curves to several vasoactive agents in the cerebral arteries. Together, these results indicate impairment of vasodilatory activities in the major cerebral arteries following SAH.

Antithrombin III inhibits the contractile responses elicited by a wide variety of agonists. Therefore, it may also play an important role in protecting cerebral vessels from undue constriction. However, the effect of SAH on the production of antithrombin III has not been clarified. It should be examined.

Endothelial damage also produces impairment of the barrier function of the major cerebral arteries. This allows access of vasoactive substances in the plasma to the media from which they are normally excluded by the intimal barrier.

Vascular endothelium synthesizes not only vasorelaxants such as prostacyclin and EDRF, but also endothelium-derived constricting factors. Yanagisawa, et al., have recently isolated a novel vasoconstrictor peptide, endothelin, from the culture supernatant of porcine aortic endothelial cells and have shown that endothelin is one of the most potent vasoconstrictors known. Cultured endothelial cells may approximate a state of "injury" in vivo. Therefore, the production of endothelin might be stimulated in the injured cerebral arteries after SAH.

Thus, endothelial damage that occurs following SAH could contribute to the pathogenesis of delayed cerebral vasospasm. There is no doubt that this theory cannot entirely explain the phenomenon of vasospasm. However, we believe that it is likely to lead to new and productive areas of investigation.

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References


Failed-Back Syndrome

To THE EDITOR: The article by Long, et al., is another excellent effort by this group to bring some scientific quantitation to the confusing melange of syndromes which constitute the failed-back syndrome (Long DM, Filtzer DL, BenDebba M, et al: Clinical features of the failed-back syndrome. J Neurosurg 69:61–71, July, 1988). By quantitating the disturbing frequency with which major psychiatric problems are encountered in these patients and the high frequency of spinal surgery (the type not specified) performed for indications less than ideal, the authors certainly have offered helpful guidelines for all surgeons who undertake primary surgery on patients with low-back diseases. However, I heartily agree with Dr. Long that decision-making regarding surgery for low-back disorders is one of the most intellectually challenging aspects of all neurosurgery, since it must take into account the severity, significance, and persistence of the patient's pain and the patient's own insistence, in addition to more easily quantifiable and "scientific" criteria. Undertaking a well-intentioned operation (and performing it well) out of desperation is not justifiable unless prior to undertaking surgery the surgeon has carefully considered the multitude of alternative diagnostic possibilities, the wide spectrum of noninvasive and needle-invasive therapies, and even the range of various operative possibilities available. It is the consideration of this wide range of diagnostic and therapeutic possibilities that makes this field so intellectually challenging to the neurosurgeon — or at least should make it so!

I was somewhat surprised by two omissions from the list of confirmed diagnoses. Many of the "failed-back" patients whom I have seen have ultimately been shown to be suffering from symptomatic facet syndromes or painful arthralgia of the disc with or without abnormal mobility. Just as all other joints of the body are subject to arthritis and arthralgia, I have found considerable numbers of the patients referred to me to be suffering from such conditions in their spinal joints, and many of these patients respond to therapies directed at their arthralgia.

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