MULTIPLE IMAGING PROCEDURES 2

CENTRAL NERVOUS SYSTEM

APPROACHES TO RADIOLOGIC DIAGNOSIS

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Pneumoencephalography
Myelography

edited by
Samuel M. Wolpert

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Volume 2

CENTRAL NERVOUS SYSTEM

Approaches to Radiologic Diagnosis

Edited by

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Volume 2

CENTRAL NERVOUS SYSTEM

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In memory of Lionel,
who initiated me into radiology.

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PREFACE

One of the major thrusts in neuroradiology today is toward increased sophistication in diagnostic imaging procedures. The manufacturing companies, recognizing this trend, have responded with improved X-ray technology that permits ever smaller lesions to be detected with greater safety and decreased morbidity. The advancing technology has lead to improvements in the standard imaging procedures, such as angiography, pneumoencephalography, ventriculography, myelography, complex-motion tomography, radionuclide scans, cisternography, and, more recently, computed tomography. This avalanche of increasing sophistication, while mechanically and aesthetically pleasing to those carrying out the studies, has lead to problems in the efficacious utilization of these procedures.

While computed tomography has recently jumped to the forefront of the technologic avalanche, the other techniques have not been eliminated, though they are used less frequently. The different techniques can be complementary or supplementary to each other, depending on the specific clinical situation. The physician faced with the primary care of the patient is justified in being confused as to the relative values of the many available procedures. If computed tomography can provide such excellent diagnostic images, when should angiography be advised for the investigation of a patient with a brain tumor? How should one investigate the patient with a suspected herniated lumbar disc—Pantopaque myelography, metrizamide myelography, or iliolumbar venography? What about the management of a patient with a suspected cerebellopontine angle tumor or a pituitary adenoma? Should patients with suspected acoustic neurinomas be investigated by plain films, complex-motion tomography, computed tomography, cisternography, or pneumoencephalography?

Questions such as these confront many of us today in our practice of neuroradiology. Many of the answers are unavailable, since controlled studies of one radiologic examination as compared with another for all neurologic disease have not been carried out yet. The state of the art is evolving and the "best" test today may not be the "best" test tomorrow. In investigating many if not all neurologic problems where radiology is helpful, the neuroradiologist must use, if only by trial and error, mental road maps. Systematic plans of investigation, together with the clinical knowledge of the probable location and nature of a disease process, are analyzed and weighed by the neuroradiologist so that the correct "answer" is derived as quickly and safely as possible.

The authors in this book have been requested to describe their "road maps" and their neuroradiologic approaches to particular clinical problems. In no way is this text meant to supplant, even partially, any of the excellent didactic textbooks on neuroradiology now available, nor is this text meant as a comprehensive evaluation of all potential neurologic diseases that can be investigated by X rays. The topics have been selected to act as a guide to an "orientation approach" to certain neurologic diseases. In addition to best medical care, considerations such as the wishes of the referring physician, the availability of the appropriate equipment, the availability of a rapid emergency service, the cost of that service, etc., often dictate the methods of investigation. This book, however, stresses a utopian approach. The thrust is toward a neuroradiologic approach under optimal conditions, and the answers offered in this text are presented in this light. It is hoped that this will guide the referring physician and advising radiologist to the goal of expedient and accurate diagnosis at costs acceptable to our medical system.

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CONTENTS

ACKNOWLEDGMENTS vii

PREFACE viii

CONTRIBUTORS x

1. SUBARACHNOID HEMORRHAGE
   Samuel M. Wolpert, M.B., B.Ch., D.M.R.D. 1

2. CEREBROVASCULAR DISEASE IN THE ADULT
   Samuel M. Wolpert, M.B., B.Ch., D.M.R.D. 15

3. CEREBRAL TUMORS
   Samuel M. Wolpert, M.B., B.Ch., D.M.R.D. 35

4. INTRASELLAR AND PERISELLAR LESIONS
   Paul F. J. New, M.D., and Kenneth R. Davis, M.D. 57

5. CEREBELLOPONTINE ANGLE MASSES
   Kenneth R. Davis, M.D., Stephen W. Parker, M.D., and Paul F. J. New, M.D 83

6. CEREBRAL TRAUMA
   Eric N. Faerber, M.B., B.Ch., D.M.R.D. 95

7. THE RADIOLOGIC INVESTIGATION OF DEMENTIA AND CEREBRAL ATROPHY
   Marjorie LeMay, M.D. 109

8. DEGENERATIVE SPINAL DISORDERS
   Steven B. Hammerschlag, M.B., B.Ch., F.R.C.P.(C) 129

9. CONGENITAL SPINAL DISORDERS
   Richard A. Baker, M.D., and Roy D. Strand, M.D. 163

10. SPINAL AXIS TUMORS
    Richard A. Baker, M.D. 191

INDEX 209

Samuel M. Wolpert, M.B., B.Ch., D.M.R.D.

1
Subarachnoid Hemorrhage

CEREBRAL SUBARACHNOID HEMORRHAGE

The most common cause of a subarachnoid hemorrhage in adults is rupture of a saccular aneurysm of the circle of Willis. The typical clinical presentation is a sudden intense headache associated with neck stiffness and photophobia. In approximately half of the patients, the headache will be associated with a sudden transient loss of consciousness.

In about 25 percent of cases, a history of one or more sudden "minor" headaches in the weeks preceding the major attack can be elicited. Transient or permanent neurologic deficits immediately following the initial ictus can also occur and are probably due to focal areas of cerebral ischemia secondary to spasm, intracerebral hematomas, or compression of the arteries in the vicinity of the rupture by high subarachnoid pressure secondary to the hemorrhage. Rupture of a cerebral arteriovenous malformation is a less frequent cause of subarachnoid hemorrhage than rupture of an aneurysm. However, if a history of seizures is present in a patient with a subarachnoid hemorrhage, an underlying arteriovenous malformation is the likely cause. In children, arteriovenous malformations are the most common cause of subarachnoid hemorrhages.

When the subarachnoid hemorrhage is accompanied by thoracic or lumbar backache, rupture of a spinal arteriovenous malformation should be considered. A malformation in this location, however, is far less frequent than in the brain, but should be considered, particularly if a cranial origin for the subarachnoid hemorrhage has been ruled out.

Radiologic Management

SKULL SERIES

Patients with subarachnoid hemorrhage (SAH) and no associated focal neurologic signs should have skull X rays obtained early in their hospitalization. Calcification within the walls of either an aneurysm or an arteriovenous malformation (AVM) or increased vascular grooves in the calvarium secondary to the AVM can suggest the cause for the SAH. Since the incidence of these radiologic changes is low, it certainly is acceptable to forego a complete skull series and obtain only lateral and Towne X rays as scout films prior to angiography.

COMPUTED TOMOGRAPHY

In order to plan surgical treatment, it is important to locate the bleeding site and to define the anatomy of the aneurysm or the AVM and of the adjacent vessels. Angiography remains the definitive procedure for establishing and documenting the site of the hemorrhage and, until recently, was the preferred initial procedure. The advent of computed tomography (CT) and its proven usefulness have changed the management of patients with SAH, and now CT should precede the angiogram whenever possible. Typically, an AVM appears as serpiginous high-density lesions after the administration of contrast material on CT (Fig. 1-1).

In a series of 41 angiographically proven intracranial angiomas (all except one were AVMs), CT was diagnostic of the lesion in 27 patients. A focal abnormality was seen in a further 11 which, in the clinical context, suggested the correct diagnosis.[1] Not only may CT immediately alert the physician to the presence of an AVM or an aneurysm (if the aneurysm is sufficiently large) (Fig. 1-2) but clinically silent intracerebral hematomas or edema secondary to vascular spasm may also be found even though unsuspected. Furthermore, the CT scan, if carried out in the first week following a SAH due to rupture of an aneurysm (Fig. 1-3), can alert the angiographer to the site of bleeding in 85 percent of patients by the presence of a hematoma, infarction, or edema adjacent to the ruptured lesion.[2] In another series of 100 patients with nontraumatic intracerebral hemorrhages, observation of the anatomic localization of the hemorrhage differentiated a subarachnoid hemorrhage from an intracerebral hemorrhage in 90 percent of the patients. Anterior communicating aneurysms were diagnosed with 100 percent accuracy.[3]

In a further series, extravasated blood was recognized in 42 of 46 patients (90 percent) presenting clinically with SAH.[4] Thrombosed aneurysms may be diagnosed by the demonstration of calcifications in their walls. Once the CT suggests the site of the aneurysm, definitive angiography can then be

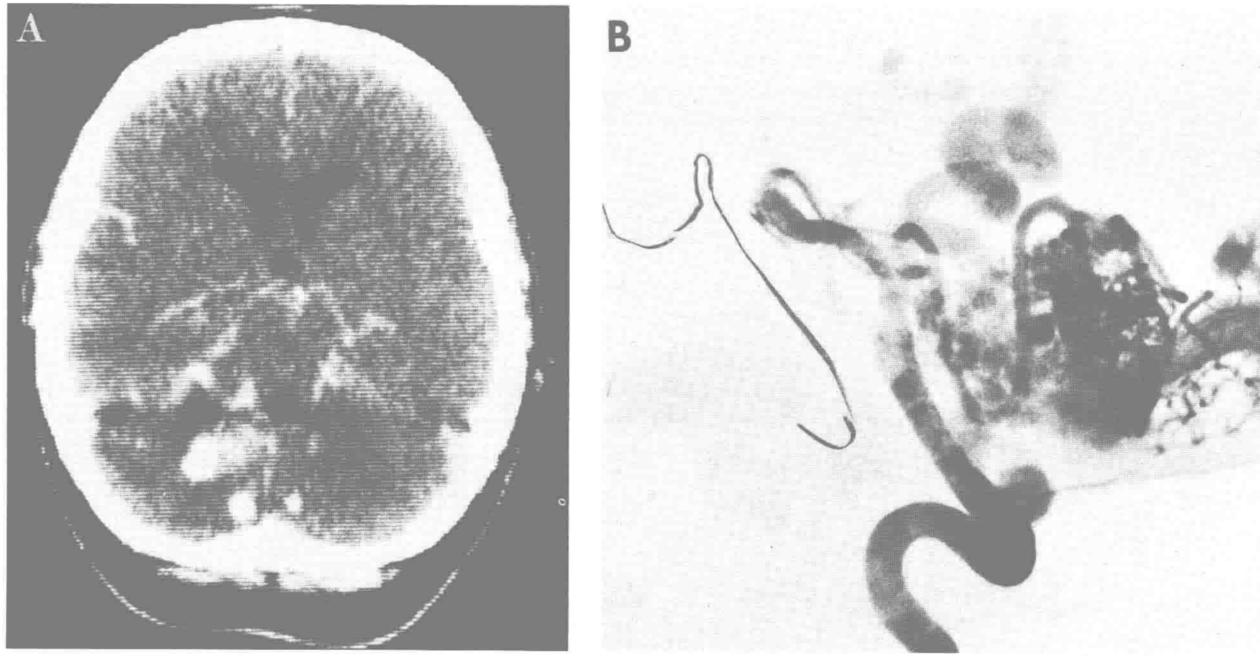

Fig. 1–1. (a) Contrast enhanced CT scan demonstrates serpiginous high-density channels representing enlarged arterial and venous vessels mainly in the left cerebellar hemisphere. (b.) Left vertebral angiogram demonstrates a large arteriovenous malformation fed by the posterior inferior cerebellar artery. (From Wolpert SM: Neuroradiology of the Posterior Fossa, in *Surgery of the Posterior Fossa*. New York, Raven Press, 1979.)

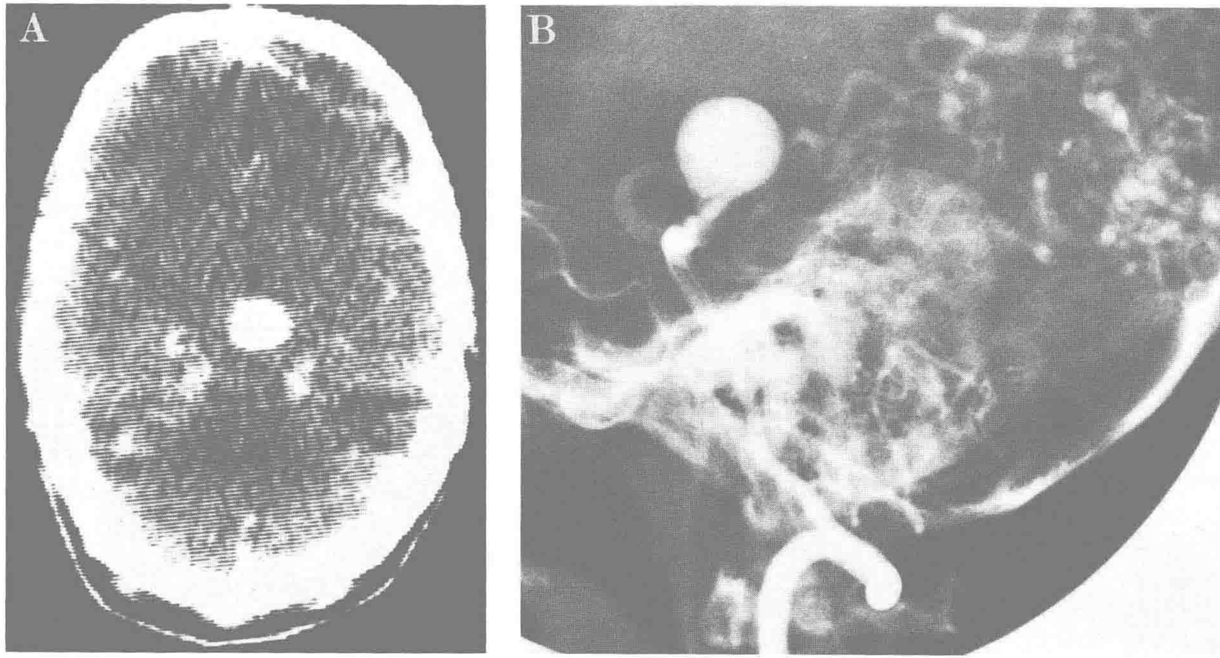

Fig. 1–2. (a.) Contrast enhanced CT scan demonstrates a high-density lesion adjacent to the third ventricle. (b.) Left vertebral angiogram demonstrates an aneurysm originating from the apex of the basilar artery. The terminal branches of the posterior cerebral artery terminate in an occipital lobe arteriovenous malformation. Arteriovenous malformations are associated with cerebral aneurysms in 1.5 percent of patients. (From Wolpert SM: Neuroradiology of the Posterior Fossa, in Surgery of the Posterior Fossa. New York, Raven Press, 1979.)

carried out with the high likelihood that the initial injection will demonstrate the bleeding site.

The ability of the CT scan to demonstrate the ventricles is also of considerable benefit. With repetitive SAH or prolonged cerebral vasospasm, hydrocephalus frequently occurs and can be recognized on the CT scan. On occasion, hydrocephalus can develop relatively acutely within the first few days after the SAH, due to an acute rise in the cerebrospinal fluid pressure.

A CT scan should be carried out as an emergency procedure in patients admitted to the hospital with focal neurologic deficits following a SAH, as well as in lethargic or moribund patients. The removal of a superficial intracerebral hematoma in these patients may be a lifesaving procedure. Underlying aneurysms can be surgically treated at the same time, but the presence of an unexpected large AVM may prove troublesome to the surgeon. For these reasons, angiography should follow the CT scan if time permits.

CEREBRAL ANGIOGRAPHY

Modern surgical management of a patient with an uncomplicated ruptured cerebral aneurysm is to delay operation once the diagnosis has been established and to attempt to maintain the patient until approximately the 10th day after the hemorrhage, at which time elective surgery may be carried out.[5] Some neurosurgeons advocate earlier surgery if the patient's condition is good with no neurologic deficit.[6] Similarly, the surgical management of the patient with a ruptured AVM, if unaccompanied by a hematoma, is elective. Depending on the morphology, size, and site of the malformation, management may be conservative medical, embolization with Silastic® beads, or surgical removal. For these reasons, cerebral angiography need not be carried out as an emergency procedure for SAH, but can be performed within 24 hours of the patient's admission to the hospital.

Aneurysms are most frequently found at the base of the brain in the circle of Willis, but are also found—not infrequently—along the middle cerebral artery, usually at its proximal bifurcation. More peripherally located aneurysms are usually mycotic in nature. Approximately 15 percent of aneurysms occur in the posterior fossa circulation, particularly at the apex of the basilar artery or at the origin of either posterior inferior cerebellar artery from the vertebral artery. Accordingly, vertebral angiography must include visualization of the upper few centimeters of both vertebral arteries. This is accomplished (1) by reflux of contrast material down the opposite vertebral artery after an ipsilateral injection with a moderately high injection pressure or (2) by separate injections into each vertebral artery. Even if one aneurysm is found, it is necessary to investigate all possible sites for the origin of other aneurysms since in approximately 20 percent of patients aneurysms are multiple.

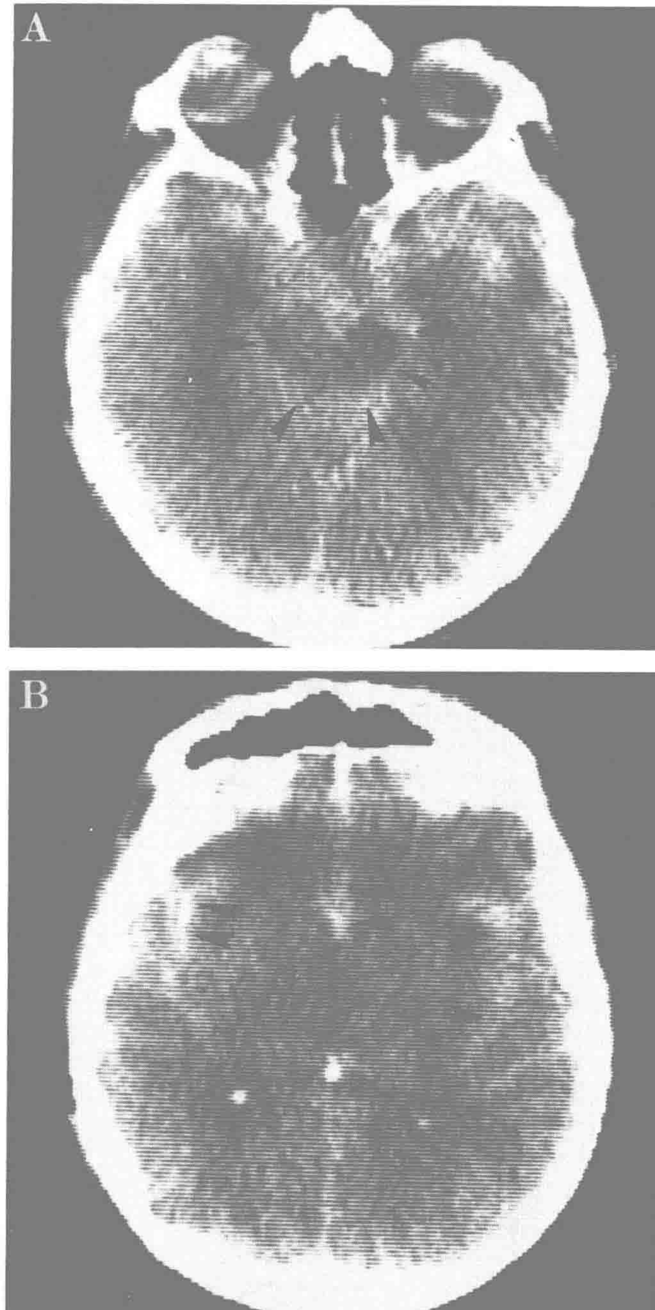

Fig. 1–3 (a.) Nonenhanced scan demonstrates high-density areas representing blood surrounding the midbrain (arrowheads). Blood is also in the sylvian fissures. (b.) Scan obtained 13 mm craniad to 1-3a again demonstrates blood in the sylvian and interhemispheric fissures (arrowheads). *Figure 1–3 continues on following page.*