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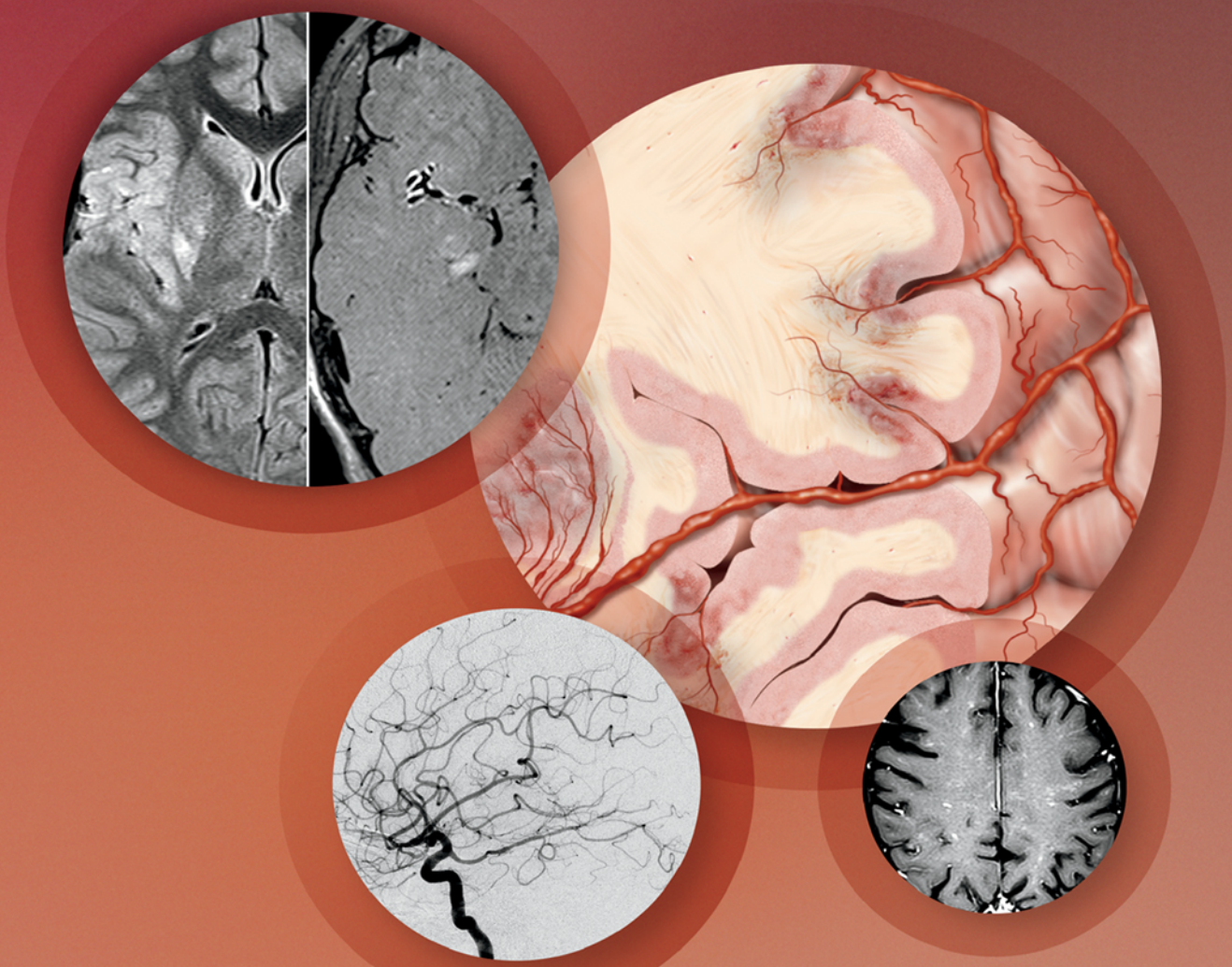

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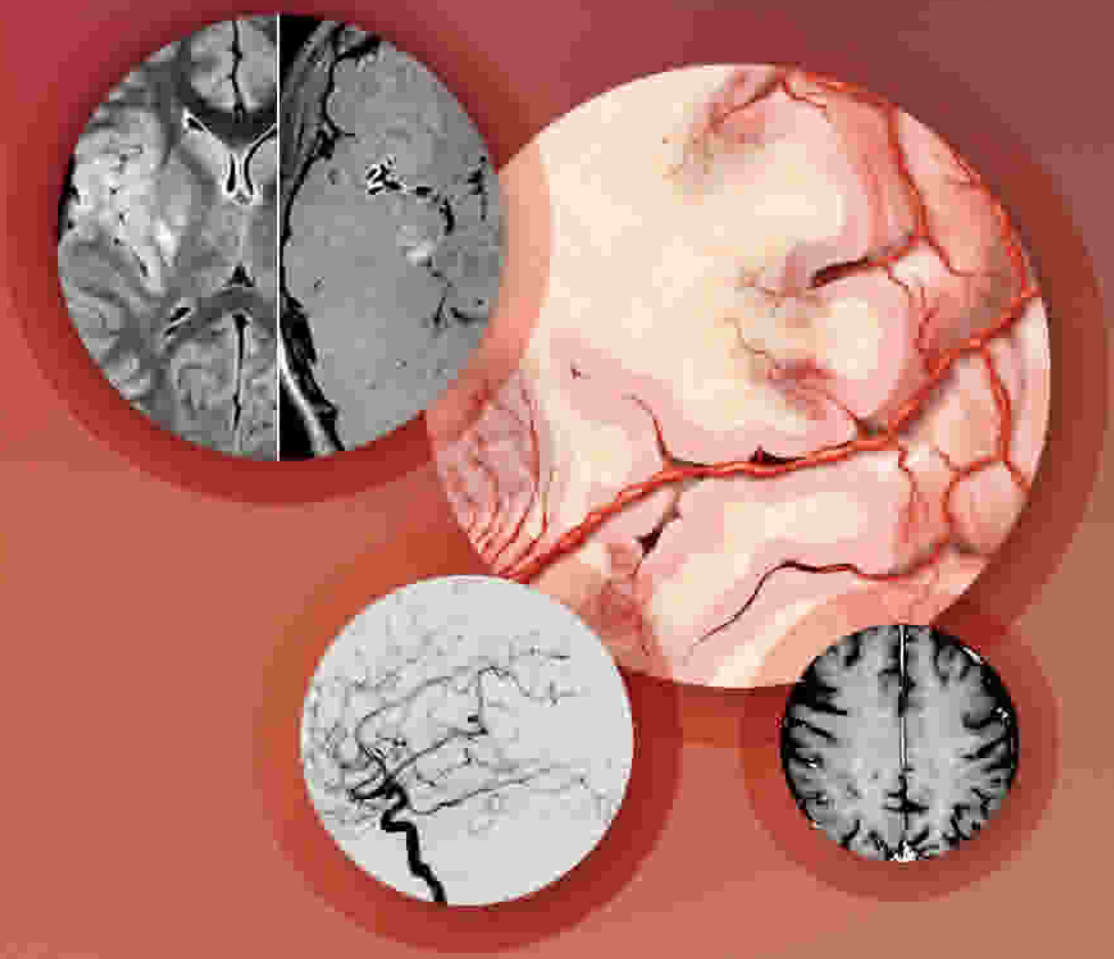

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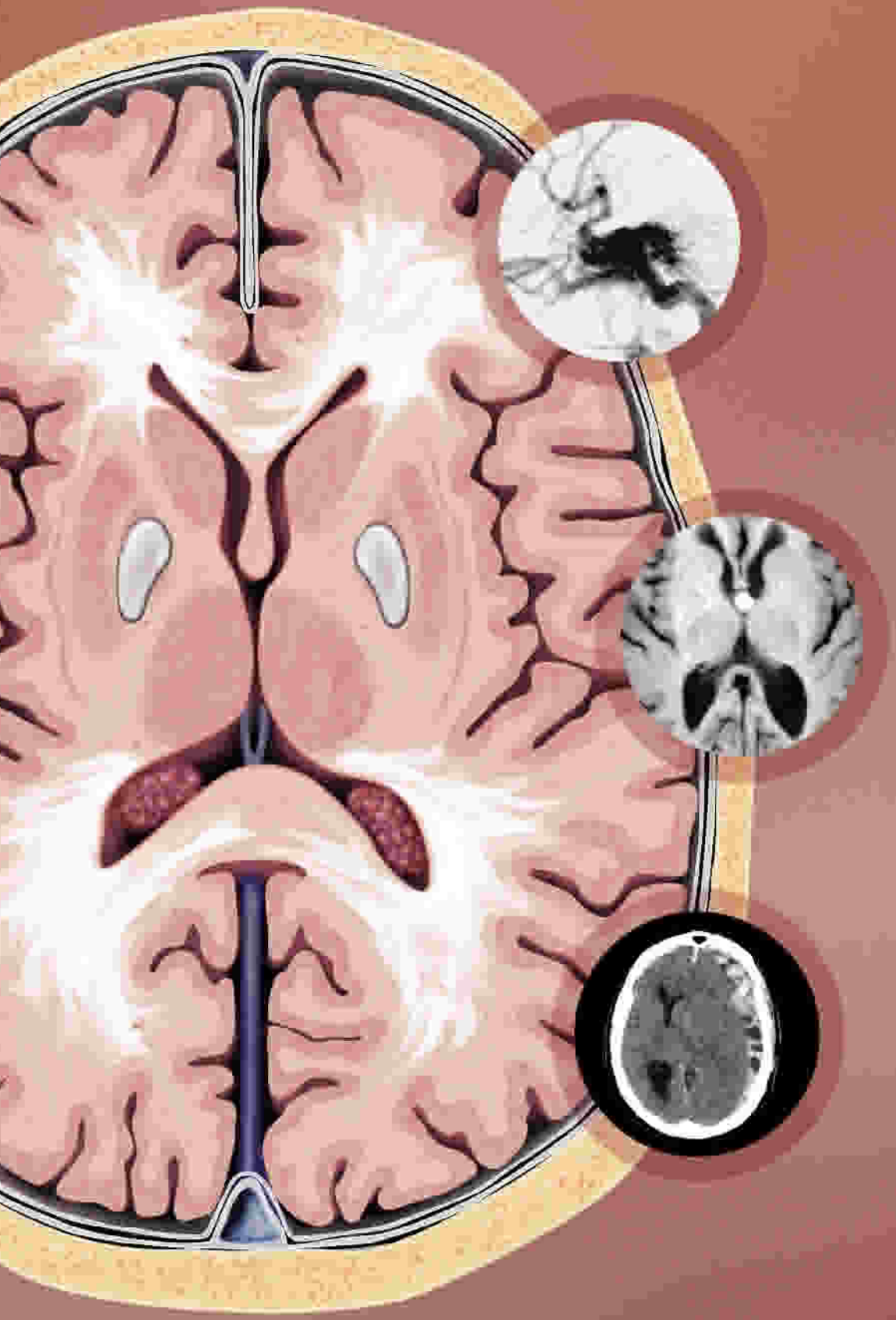

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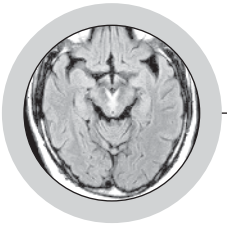

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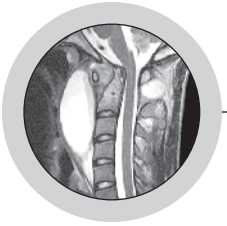

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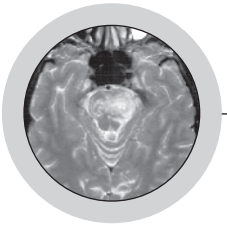

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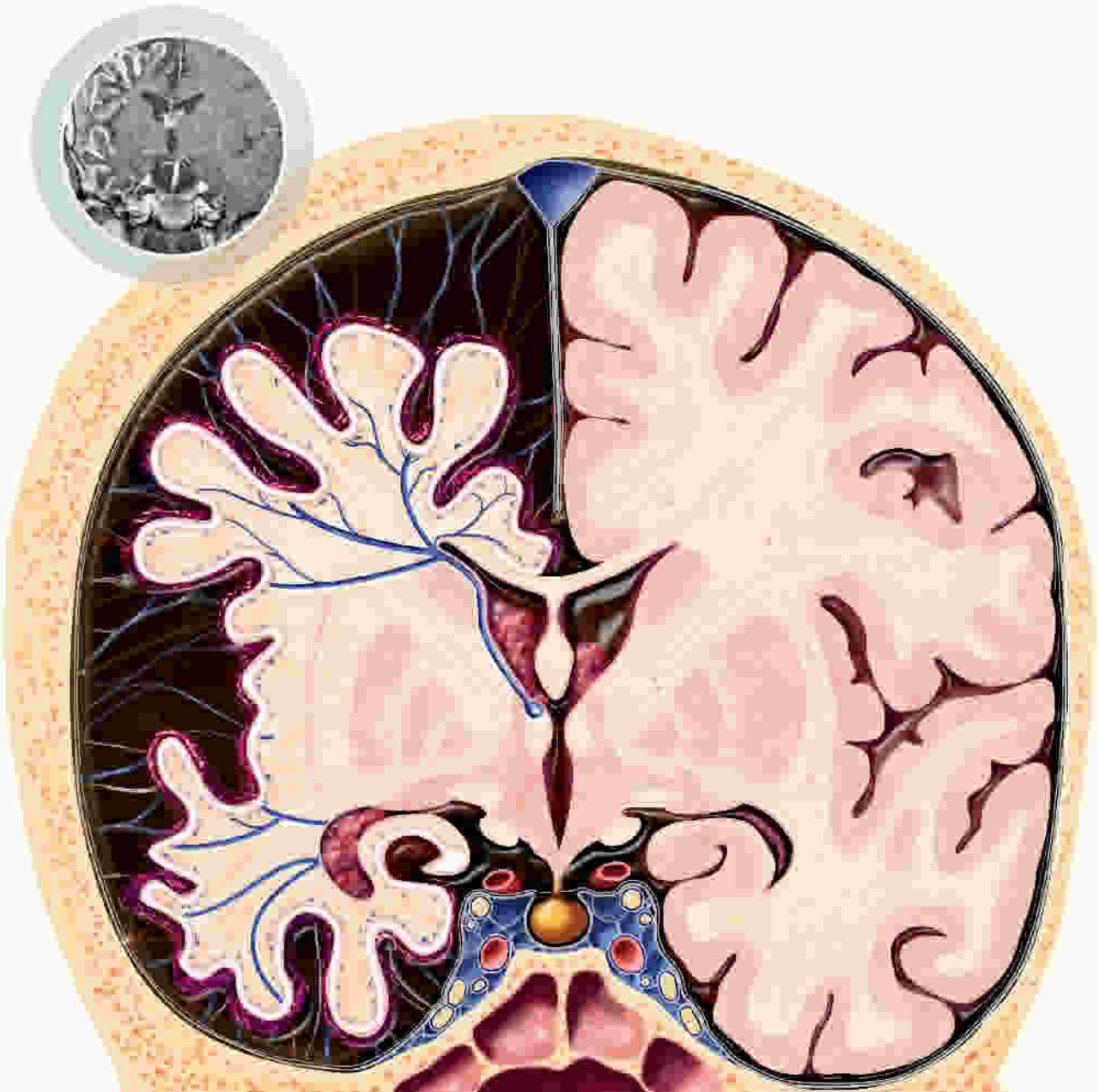
Dedication

To my husband, Michael Varner, for his neverending love and encouragement.

KBD



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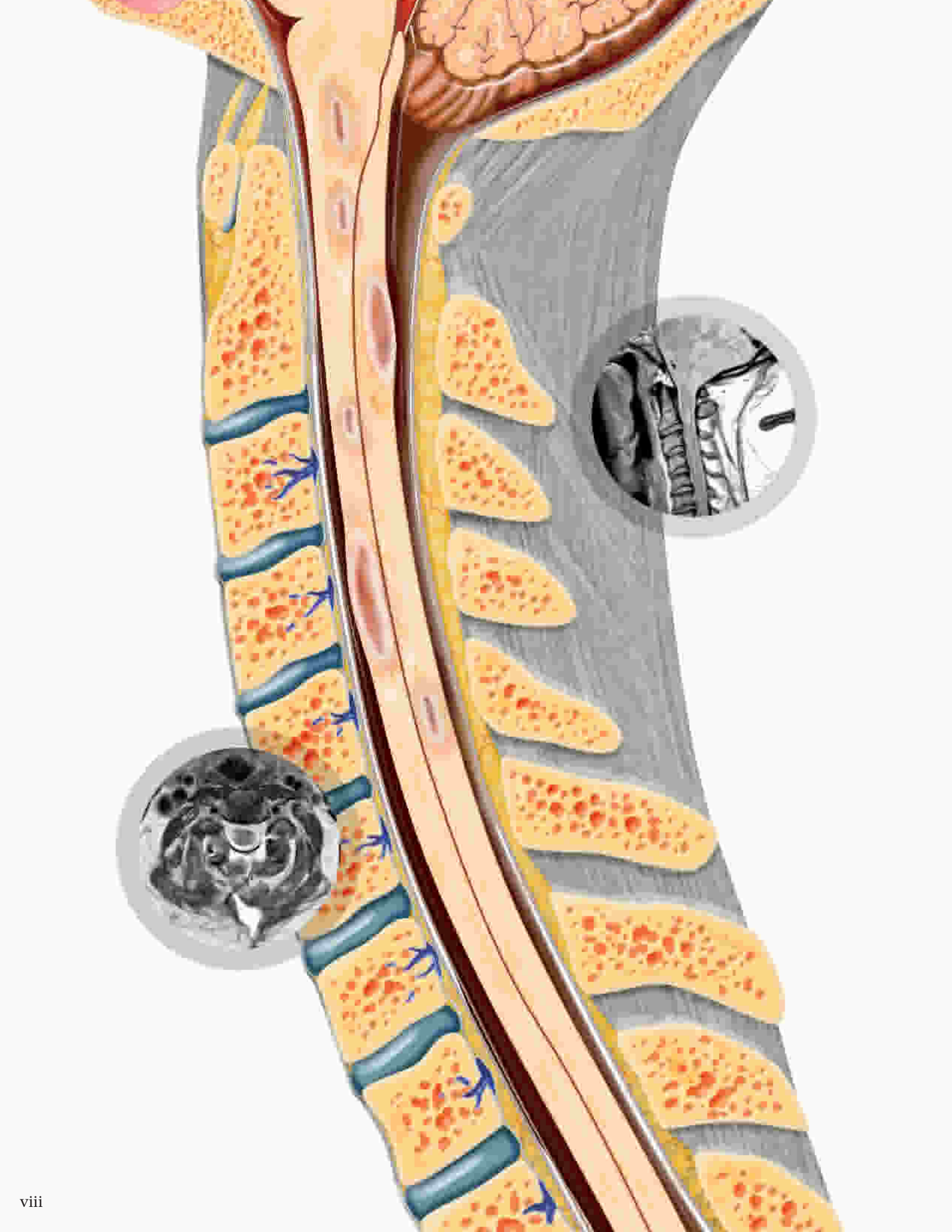

Preface

Anne Osborn and I have been colleagues for almost our entire careers. When she approached me about joining her to edit a book for neurologists on imaging, I didn't have to think twice. Neurologists use imaging every day as an extension of the neurological examination. In fact, imaging is critical to making the correct diagnosis and following patients. Yet, the best imaging books are all in neuroradiology. Here was a chance to partner with one of the premier neuroradiologists to produce a book that would be practical and useful to my neurological colleagues around the world. What wasn't to like?!

The book's purpose is to provide key imaging findings to the most common and important neurological disorders in an easy-to-understand format, using typical imaging examples, pathological examples when appropriate, and gorgeous drawings that illustrate key findings. We have also included clinical photos where indicated.

The book is divided into three parts—an introduction to imaging in general, imaging of the brain from pathology-based and anatomic-based diagnoses, and spine imaging. There are overview chapters to difficult subjects like congenital malformations, trauma, vascular anatomy, neoplasms, infectious diseases, and metabolic disorders. There are anatomic overviews of the ventricles, the pituitary, cerebellar pontine angle, and the orbit. The spine section also has a wonderful review of normal anatomy and then develops a complex subject made simple.

Each chapter is written by outstanding neuroradiologists who point out the main imaging findings for each disorder or anatomic area. We then addressed key clinical features. The organization of each chapter makes it really easy for a neurologist to quickly know the key terminology, imaging findings, pathologic underpinnings, and important clinical details. Images were specifically chosen to be classic examples, and Anne Osborn labored for many hours putting arrows on every structure that is described so that all of us neurologists know exactly what the key findings are.

We see this book being of value to every practicing neurologist or physician who sees general neurology patients. In addition, we see residents using this book to study for in-service and board exams.

We have many people to thank in producing this book. First, we relied on two fellows from the University of Utah who completed neurological residencies and are currently in fellowship—Dr. Kelsey Juster-Switlyk and Dr. Reuben Valenzuela. These two highlighted areas that were not clear or key points that were missing. Our fabulous senior editor, Dr. Karen E. Concannon, kept us on schedule.

Finally, we thank our families and colleagues for giving us the time and space to finish the project.

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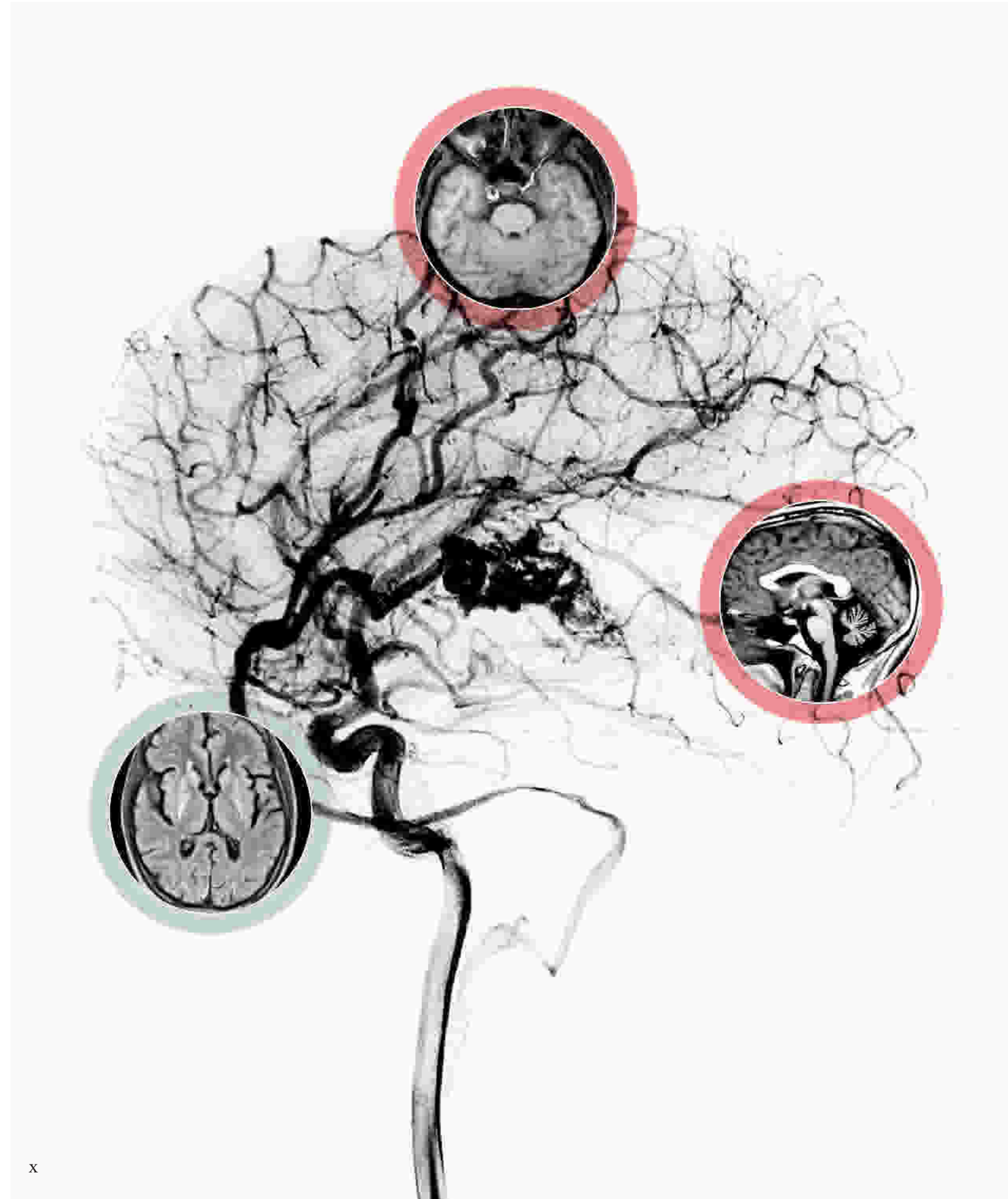

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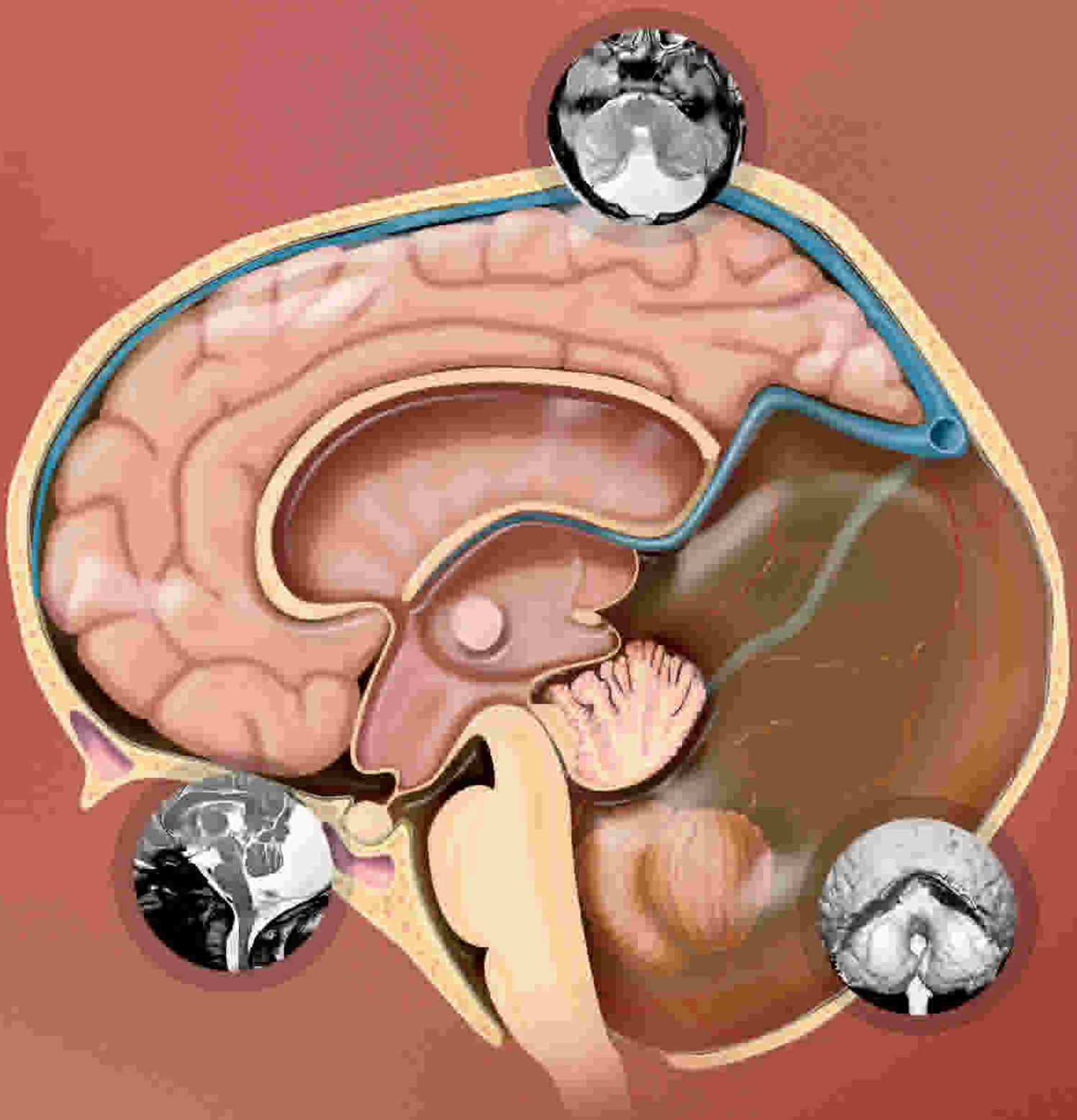

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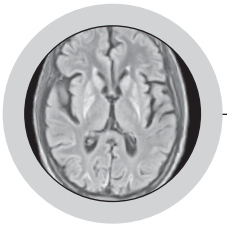

Part I: Brain

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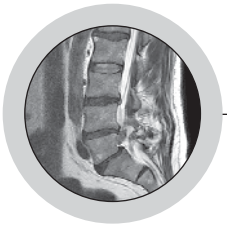
Pathology-Based Diagnoses:
Malformations, Trauma, and Stroke

Section 2:
Pathology-Based Diagnoses:
Neoplasms, Cysts, and Disorders

Section 3:
Anatomy-Based Diagnoses



Part II: Spine

Section 1:
Normal Anatomy and Congenital Disorders

Section 2:
Trauma and Hemorrhage

Section 3:
Degenerative Diseases and Arthritides

Section 4:
Infection and Inflammatory Disorders

Section 5:
Neoplasms, Cysts, and Other Masses

Section 6:
Peripheral Nerve and Plexi

TABLE OF CONTENTS

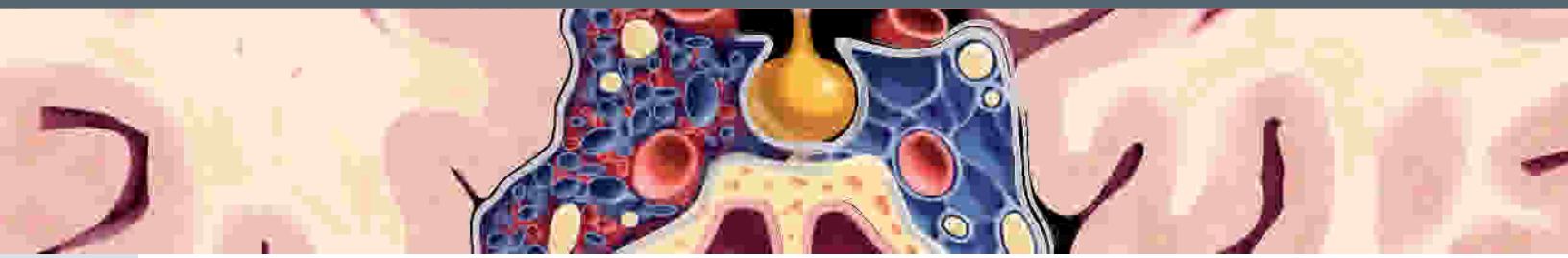


TABLE OF CONTENTS

TABLE OF CONTENTS

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TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

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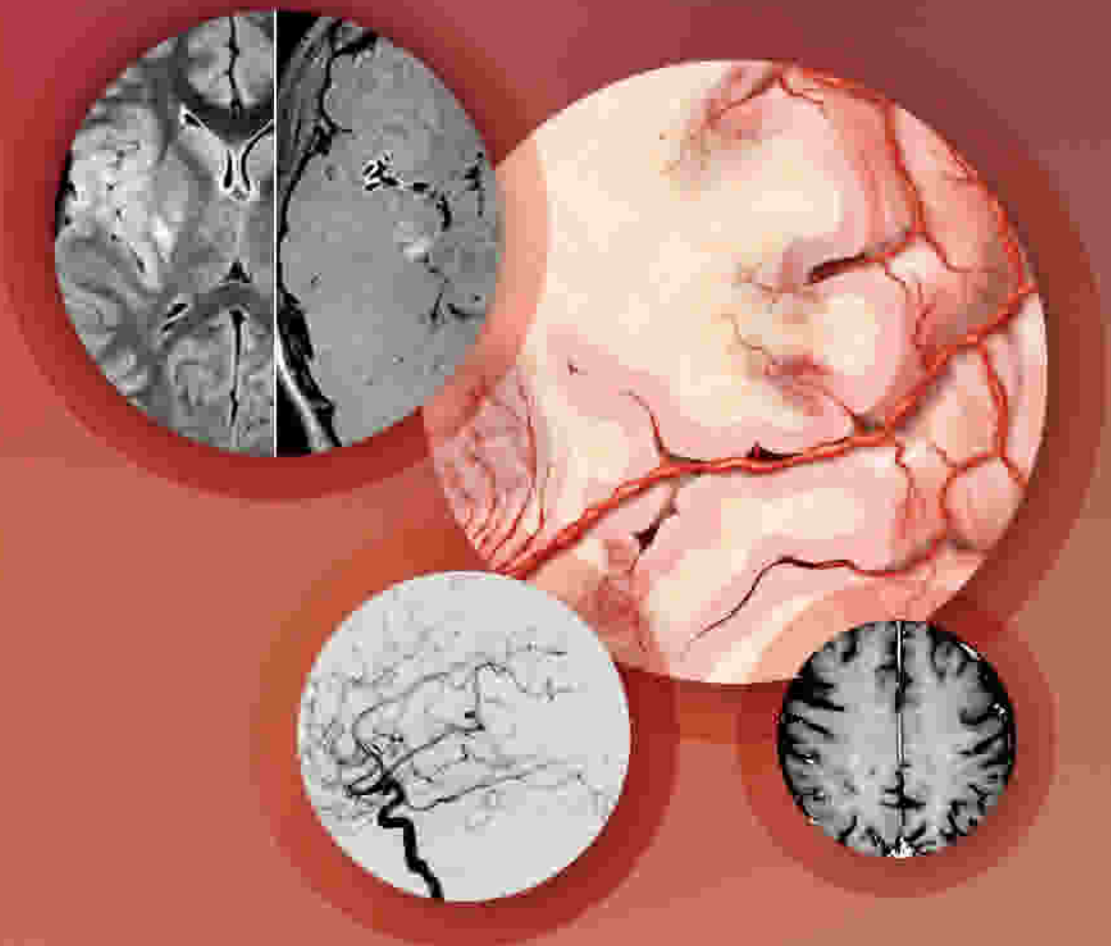

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Introduction

Rapid advancement of medical imaging in the last couple of decades has significantly enhanced the role of imaging in medicine. Imaging plays an integral role in the evaluation of neurological disorders. It is performed for diagnosis, assessing efficacy of therapy, follow-up, and guidance for procedures.

Benign neurological disorders and life-threatening neoplasms may present with similar overlapping symptomatology, which could be relatively nonspecific. Clinical history combined with a good neurological evaluation is often followed by lab investigations, electroencephalography, lumbar puncture, and other investigations. Computed tomography (CT) and magnetic resonance (MR) form the backbone of the imaging work-up of these patients. Neurological disorders tend to be complex, and arriving at a diagnosis involves knowledge of neuroanatomy, pathology, physiology, and diagnostic tools such as neuroimaging.

Imaging Modalities

In the past, radiography ("plain films" and more recently digital radiography) played a significant role in imaging. With the advent of advanced imaging like CT and MR, the role of radiography has significantly diminished. Currently CT and MR are the most commonly performed imaging modalities for diseases of the brain and spine. In addition to exquisite anatomical detail, advanced MR techniques like MR perfusion, MR spectroscopy (MRS) and functional MR (fMRI) provide physiological information.

Likewise single-photon emission CT (SPECT) and positron emission tomography (PET)-CT imaging have a distinct contribution, as they can also provide structural and functional images of the brain. Ultrasound and color Doppler are useful in evaluating the head and neck vasculature.

CT

CT technology relies on the same physical principles as x-rays do. The differential absorption of the x-ray beam by different tissues produces varied levels of density in the image, which on CT scans are measured in Hounsfield units (HU). This can be displayed in cross-sectional format or in multiple planes. Multidetector CT (MDCT) has increased the capability of CT with faster scans, greater spatial resolution, and multiplanar reformations.

The ability of CT to image traumatic conditions of brain and spine rapidly has made it invaluable in acute neurotrauma management. Lesions commonly seen on CT include calvarial fractures, acute intraaxial and extraaxial hemorrhage, hemorrhagic contusions, diffuse axonal injury, and spinal fractures.

CT also plays a pivotal role in the management of acute stroke and is the first-line imaging modality. It quickly helps in determining whether the signs and symptoms being observed can be attributed to intracranial hemorrhage, ischemic stroke, or a mass lesion. The biggest contribution of noncontrast CT is excluding intracranial hemorrhage, so that appropriately selected patients can be started on tissue plasminogen activator (tPA). Although CT is less sensitive than MR in detecting acute cerebral ischemia-infarction, detectable changes are present on 50-60% of noncontrast CT (NECT) scans in patients with major territorial (not lacunar) infarcts.

Noncontrast CT is relatively insensitive for detection of neoplastic disease, especially when the tumor burden is small. A postcontrast CT should always be obtained when evaluating neoplastic conditions using CT.

CT Angiogram (CTA)
CTA is the study of choice for all emergent and nonemergent neurovascular conditions, including acute stroke. It is fast and less prone to artifact than MR angiography (MRA). A combined CTA of the head and neck, from the aortic arch to the cranial vertex, can be obtained with as little as 70 ml of IV contrast in < 15 seconds. Given the high prevalence of cardiogenic acute strokes, it now is possible to extend the field of coverage of CTA to include the heart in the evaluation.

CT Venogram (CTV)
CTV is similar to CTA except for an added delay for optimal visualization of the venous system. It is a fast, reliable modality to exclude dural sinus thrombosis in an emergent setting.

CT Perfusion (CTP)
CTP imaging uses the dynamics of first-pass bolus through the brain parenchyma to derive perfusion maps. Repeated CT scans through a limited region of the brain yield a time-attenuation curve for each pixel that documents the changes in tissue contrast during the bolus contrast passage. CTP software is used to process these images and generate cerebral blood volume (CBV), cerebral blood flow (CBF) , mean transit time (MTT), time to peak (TTP), and permeability (kPS) maps. CTP aims to detect the mismatch between the brain already infarcted (ischemic "core") and that at risk of infarction ("penumbra" or potentially salvageable brain). Permeability maps (kPS) are helpful in tumor imaging to grade gliomas and to differentiate between tumor recurrence and radiation necrosis.

MR

The primary origin of the MR signal used to generate almost all clinical images comes from hydrogen nuclei. Hydrogen nuclei consist of a single proton that is constantly spinning. A radio frequency pulse (RF pulse) emitted from the scanner results in some of the hydrogen protons being "knocked" 180° out of alignment with the static magnetic field. As the energy from the RF pulse is dissipated, the hydrogen protons will return to alignment with the static magnetic field. The MR signal is derived from the hydrogen protons as they move back into alignment with the magnetic field. The MR signal is then broken down and spatially located to produce images.

T1, T2, and proton density are the fundamental parameters of MR and determine the contrast between tissues. MR sequences that emphasize tissue differences in T1 relaxation are called T1 weighted, and those that emphasize T2 relaxation are called T2 weighted. Tissues with short T1 relaxation time such as fat, melanin, and protein produce high signal on T1-weighted sequences and appear "bright," whereas cerebrospinal fluid (CSF) is relatively dark. CSF has a long T2 relaxation time and appears bright on T2-weighted sequences.

Spin echo and gradient echo are 2 basic sequences in MR. All other sequences are variations of 1 of these sequences and are used to better characterize specific tissue types. MPRAGE is a 3-dimensional, thin-section T1-weighted volumetric acquisition that is increasingly utilized for evaluating a broad spectrum of brain disorders.

Fluid-attenuation inversion recovery (FLAIR) sequence is used to eliminate the signal from CSF, which thus appears dark. It is useful for highlighting parenchymal lesions that lie