Magnetic Resonance Imaging in Stroke

Magnetic resonance imaging (MRI) provides non-invasive information about the brain's blood flow, water movement and biochemical abnormalities following stroke, and advances in MRI are transforming the investigation and treatment of cerebrovascular disease. Echoplanar techniques with diffusion- and perfusion-weighted imaging, together with developments in magnetic resonance spectroscopy and angiography, are replacing CT scanning as the diagnostic modality of choice. In this profusely illustrated book, world leaders in these technologies review the scientific basis and clinical applications of MRI in stroke. It will appeal to a broad readership including stroke physicians, neurologists, neurosurgeons, rehabilitation specialists, and others with a clinical or research interest in cerebrovascular disease.

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Preface

Stroke is a leading cause of death in Western countries, with a mortality rate higher than most forms of cancer and now the commonest cause of long-term adult disability. Stroke diagnosis and management were revolutionized by the widespread introduction of computed tomographic (CT) scanning in the 1970s. CT scanning sensitively excludes cerebral hemorrhage, but early ischemic changes can be subtle. In the first few hours after stroke onset, when acute therapies such as thrombolysis are being considered, CT is often normal, although acute ischemic changes have become better recognized in recent years. Conventional magnetic resonance imaging (MRI) became widely available in most countries a decade after the advent of CT scanning, but has had a limited role in stroke diagnosis and management. Although MRI provides far better imaging of posterior fossa structures and facilitated non-invasive angiography (MRA), its sensitivity in acute stroke is not much better than CT. Other functional imaging techniques such as single photon emission computed tomography (SPECT) and positron emission tomography (PET) have been valuable research tools, but have not been of routine clinical use in the management of stroke.

Since the 1990s, the increasingly widespread availability of echoplanar MRI technology facilitated the introduction of diffusion-weighted imaging (DWI), perfusion imaging (PWI) and magnetic resonance spectroscopy (MRS). Diffusion-weighted imaging allows the hyperacute evaluation of the ischemic core within minutes of stroke onset and the distinction between acute and chronic

ischemic lesions. It represents an extraordinary advance in stroke imaging, specifically in the region of ischemic tissue that is usually destined for infarction. PWI provides a measure of the hypoperfused tissue at risk, particularly in the ischemic penumbra, where acute therapies are targeted. Currently, PWI is dependent on contrast injection, but arterial spin labelling may well supersede this technique. These new MRI methods also permit topographic analysis of acute infarcts and some insights into stroke pathophysiology and prognosis. Concurrent MRA allows analysis of acute arterial occlusion and monitors recanalization. Magnetic resonance spectroscopy provides insights into metabolically deranged cerebral tissues and provides information that is complementary to DWI and PWI. These new techniques are transforming the diagnosis and management of acute stroke. We believe that CT is likely to be widely replaced by these new MR techniques within the next few years. This has already occurred in many expert stroke centres.

In this book we have aimed to provide a comprehensive and up-to-date summary of the dramatic developments that have occurred in this field in the last few years and have also tried to predict likely advances. The scope of the text includes background on the importance of precise stroke diagnosis, the current uses of CT including perfusion imaging and an introduction to standard and echoplanar MRI techniques. Recent advances in MRI permit exclusion of intracerebral hemorrhage and this is currently being tested in randomized trials. A series of chapters details the diagnostic advances facilitated by MRA, DWI, PWI and MRS. Following a review of the pathophysiology and clinical importance of the ischemic penumbra, our contributors illustrate the role of MRI in drug development and selection of acute therapies. Recent studies provide insights into the use of MRI in individualization of the time window, providing a 'tissue clock' for therapeutic interventions such as thrombolysis. Currently, MR-based studies are testing the hypothesis that perfusion–diffusion mismatch, the postulated MR signature of the ischemic penumbra, can suggest the benefit of thrombolysis beyond the clinically established 3-hour time window. Finally, functional brain imaging using brain activation studies and MRI are leading to a better understanding of brain processing and brain recovery after stroke.

In this book, we have targeted neurologists, other stroke physicians, neuroradiologists and other clinicians involved in stroke diagnosis, imaging and management. We have aimed to encapsulate the development, current and emerging clinical role of MRI in stroke. We are grateful for the contributions of our chapter authors, all leaders in the field of MRI and stroke. A few years ago, experts debated whether MRI, in acute stroke diagnosis, was ready for 'prime time'. After reading this book, we suspect you will agree that it is.

Stephen Davis, Marc Fisher and Steven Warach, 2002