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978-0-521-86898-3 - Clinical MR Spectroscopy: Techniques and Applications

Peter B. Barker, Alberto Bizzi, Nicola De Stefano, Rao P. Gullapalli and Doris D. M. Lin

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Preface

Magnetic resonance spectroscopy (MRS) allows the non-invasive measurement of selected biological compounds in vivo. Feasibility was first demonstrated in humans in the mid-1980s. Since that time, much experience has been accumulated with the use of MRS in both research and clinical applications. Nearly all magnetic resonance imaging (MRI) scanners have the capability to perform MRS, and MRS techniques still continue to improve, even after two decades of development. MRS has been applied to the study of all major pathologies, particularly in the brain, but has also found application in other organ systems as well, most notably in the breast and prostate.

In spite of this considerable research effort and the unique biochemical information provided, only limited integration of MRS into clinical practice has occurred to date. There are multiple reasons for this, including non-standardization of acquisition and analysis protocols, limited vendor support, difficulties in interpretation (particularly for radiologists without a background in MRS), limited perceived “added-value” above conventional MRI, and lack of reimbursement.

This book is intended to address some of these issues. It gives the reader a solid basis for understanding both the techniques and applications of clinical

MRS. Recommendations are made for MRS protocols, and information provided on normal regional- and age-related metabolic variations in the brain. Detailed information about the role of MRS in evaluating pathologies involving the central nervous system, breast, prostate, and musculoskeletal systems is provided. The book also discusses the limitations of MRS, such as its low spatial resolution (e.g. compared to MRI), common artifacts, and diagnostic pitfalls.

The aim of this book is to provide a practical reference work that covers all aspects of in vivo spectroscopy in humans for clinical purposes. As such, it should be a useful guide for radiologists, oncologists, neurologists, neurosurgeons, and other physicians who may be interested in using MRS in their practices. We hope that more widespread adoption of MRS into the clinic will lead to better diagnoses and improved outcomes for individual patients.

Peter Barker, Baltimore

Alberto Bizzi, Milan

Nicola De Stefano, Siena

Rao Gullapalli, Baltimore

Doris Lin, Baltimore

Acknowledgments

PBB	For Catherine and Stephanie
AB	For Anna, Lorenza, and Caterina, who allowed me to devote energy and time to this project
NDS	For Simona, Giorgio, and Andrea
RPG	For Asha. For her enormous patience!
DDML	In loving memory of my father, Daniel

Abbreviations

AD	Alexander disease	MCD	malformations of cortical development
AD	Alzheimer’s disease	MCI	mild cognitive impairment
ADC	apparent diffusion coefficient	MEG	magnetoencephalography
ADEM	acute disseminated encephalomyelitis	mI	<i>myo</i> -inositol
AIS	Abbreviated Injury Scale	MOA	mixed oligoastrocytoma
ALS	amyotrophic lateral sclerosis	MRI	magnetic resonance imaging
ATP	adenosine triphosphate	MRS	magnetic resonance spectroscopy
CBD	corticobasal degeneration	MRSI	MR spectroscopic imaging
CBF	cerebral blood flow	MSA	multiple system atrophy
CIS	clinically isolated syndrome	MSM	methyl-sulfonyl-methane
CRB	Cramer–Rao bounds	MTR	magnetization transfer ratio
CSD	cortical spreading depression	MTS	mesial temporal sclerosis
CSF	cerebrospinal fluid	NAA	<i>N</i> -acetylaspartate
CSI	chemical shift imaging	NMR	nuclear magnetic resonance
CW	continuous wave	OVS	outer-volume suppression
DAI	diffuse axonal injury	PC	phosphocholine
DLB	dementia with Lewy bodies	PCPCS	Pediatric Cerebral Performance Category Scale
DRN	delayed radiation necrosis	PCr	phosphocreatine
DTI	diffusion tensor imaging	PDE	phosphodiesters
DWI	diffusion-weighted imaging	PET	positron emission tomography
ECD	Erdheim–Chester disease	Pi	inorganic phosphate
EPSI	echo-planar spectroscopic imaging	PLIC	posterior limb of the internal capsule
FFI	fatal familial insomnia	PME	phosphomonoesters
FFT	fast Fourier transformation	PML	progressive multifocal leukoencephalopathy
FID	free induction decay	PNET	primitive neuroectodermal tumors
FOV	field of view	PRESS	Point REsolved Spectroscopy Sequence
FSE	fast spin echo	PSF	point spread function
FT	Fourier transform	PSP	progressive supranuclear palsy
FTD	frontotemporal dementia	RE	Rasmussen’s encephalitis
GAMT	guanidinoacetate methyl transferase	RF	radiofrequency
GCS	Glasgow Coma Scale	SAR	specific absorption rate
GPC	glycerophosphocholine	SIAM	spectroscopic imaging acquisition mode
GSD	Gerstmann–Straussler disease	SMA	supplementary motor area
HE	hepatic encephalopathy	SNR	signal to noise ratio
HGG	high-grade glioma	SPECT	single photon emission computed tomography
HIE	hypoxic-ischemic encephalopathy	SSPE	subacute sclerosing panencephalitis
HPD	human prion disease(s)	STEAM	stimulated echo acquisition mode
ICA	internal carotid artery	SVZ	subventricular zone
IVS	inner volume suppression		
LGG	low-grade glioma		
LOH	loss of heterozygosity		
MCA	middle cerebral artery		

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SWI	susceptibility-weighted imaging	VD	vascular dementia
TBI	traumatic brain injury	VOI	volume of interest
TLE	temporal lobe epilepsy	VWM	vanishing white matter
TMS	tetramethylsilane	VZ	ventricular zone