Practical Body MRI

Protocols, Applications, and Image Interpretation

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CAMBRIDGE
UNIVERSITY PRESS

CAMBRIDGE UNIVERSITY PRESS
Cambridge, New York, Melbourne, Madrid, Cape Town,
Singapore, São Paulo, Delhi, Mexico City

Cambridge University Press
The Edinburgh Building, Cambridge CB2 8RU, UK

Published in the United States of America by
Cambridge University Press, New York

www.cambridge.org
Information on this title: www.cambridge.org/9781107014046

First published 2012

Printed in the United Kingdom at the University Press, Cambridge

*A catalogue record for this publication is available from the
British Library*

Library of Congress Cataloging in Publication data

Grand, David J.
Practical body MRI : protocols, applications, and image interpretation /
David J. Grand, William W. Mayo-Smith, Courtney A. Woodfield.
p. ; cm.
Includes bibliographical references and index.
ISBN 978-1-107-01404-6 (Hardback)
I. Mayo-Smith, William W. II. Woodfield, Courtney A. III. Title.
[DNLM: 1. Magnetic Resonance Imaging–methods. 2. Image Interpretation, Computer-Assisted. 3. Whole Body Imaging. WN 185]
616.07′57–dc23

2011029384

ISBN 978-1-107-01404-6 Hardback

To Charlie and Zoe: May you never need an MRI.
David J. Grand, MD

To my husband, Roland, and my parents, Karen and Richard, thank you for all your love and support.

To my children, Sophia and Liam, the joys of my life. You were both by my side while I worked on this book.
Courtney A. Woodfield, MD

To Margaret and Bill, who cultivated intellectual curiosity and prepared me for the world.

To dear Leslie who has supported me throughout.

And to James, Andrew, and Chris, who keep it all in perspective.
William W. Mayo-Smith, MD

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Preface

Body Imaging Divisions in the United States tend to be biased to either CT *or* MRI. This was the case at Brown/Rhode Island Hospital where CT dominated. Our Chairman, John Cronan, sought to remedy this imbalance by hiring recently trained experts in body and pelvic MRI, Drs. Grand and Woodfield.

My job as division director was to encourage the development of imaging algorithms and MRI protocols that optimized patient care. Like many academic institutions, we had had no hesitation about adding the latest sequence, but seldom took any away. Thus our protocols were lengthy and often it was not clear exactly what each sequence was used for. We needed to pare down extra sequences, minimizing imaging time without sacrificing quality or patient care. If we couldn't explain why we were running a sequence or if it was redundant, it was eliminated. This is a subjective matter and, like making sausages, not always a pretty scene.

What started as a handout for residents on their first tour of duty in body MRI became this book. It is not intended to be a reference and cover all aspects of every disease, but rather to quickly get a neophyte from "zero to fifty." David and Courtney have done a great job of writing a short, practical book that teaches residents, fellows (and attendings) with minimal exposure to body MRI the most common MRI findings in the abdomen and pelvis. It is punctuated with David's subtle sense of humor. We hope you enjoy it!

William W. Mayo-Smith, MD FACR

To the reader

Reading abdominal and pelvic MRI isn't that hard.

Yet I still have colleagues who let body MRIs languish on the worklist. And, too often, normally brash, fearless residents (and fellows) arrive at the MRI service looking as though their mother is about to leave them on their first day of kindergarten.

I was one of them.

MRI has all the ingredients to instill fear into the bravest radiology warrior. The underlying physics is complicated and, to make matters worse, it is often taught by people to whom it comes naturally.

I wish I were one of them.

Toss in a spattering of seemingly incomprehensible abbreviations, lengthy lists of protocols each with more series than the next, and more adjustable parameters than a modern office chair, and it's no wonder that the uninitiated can be intimidated.

Sadly, when we allow ourselves to be intimidated, we miss out on the wonder of MRI and its evolution into a powerful problem-solving tool.

This book is for the inexperienced. It is an accessible introduction to abdominal and pelvic MRI. It is short, but it is not particularly abbreviated. It is simply written, but it is not simplified.

It is simply what you need to know to interpret abdominal and pelvic MRI.

In it you will find all the background, protocols, and imaging features that you need to approach MRI with confidence.

When you're finished, we think you'll agree: it just isn't that hard.

Each chapter of this book follows the same format:

(1) Name of the imaging protocol.
(2) Pulse sequences in each protocol and a brief description of why each is done.
(3) Approach to image interpretation and specific pathologic entities.

David J Grand, MD

Acknowledgments

No book is written in a vacuum and, while there are three authors listed, many people contributed to the text. We thank our families for their support and our Chairman, John Cronan, who has been a constant champion of academics at Brown. We also thank all our radiologic colleagues, particularly John Pezzullo, who granted us academic time to complete this task. And finally, we thank the medical students, residents, and fellows who keep asking the questions that make academics so stimulating.

WWM-S

Glossary of terms and abbreviations used in Body MRI

2D FL	Two-dimensional FLASH (fast low-angle shot)
3D	Three-dimensional
ACR	American College of Radiology
ADC	Apparent diffusion coefficient
AML	Angiomyolipoma
AVM	Arterio-venous malformation
B	B value
BH	Breath-hold
DWI	Diffusion-weighted imaging
ERCP	Endoscopic Retrograde Cholnagiopancreatography
FISP	Fast imaging with steady precession
FNA	Fine needle aspiration
FNH	Focal nodular hyperplasia
FS	Fat saturation
FSE	Fast-spin echo
GAD(O)	Gadolinium
HASTE	Half-Fourier acquisition single-shot turbo spin echo
HCC	Hepatocellular carcinoma
IMA	Inferior mesenteric artery
IP	In phase
IPMN	Intraductal papillary mucinous neoplasm
IV	Intravenous
IVC	Inferior vena cava
L	Liter
MIP	Maximum intensity projection
MRCP	Magnetic Resonance Cholangiopancreatography
MRA	Magnetic resonance angiography
MRV	Magnetic resonance venography
MS	milliseconds
NSF	Nephrogenic systemic fibrosis
OOP	Out of phase
PCKD	Polycystic kidney disease
PD	Proton density
POST	Post administration of intravenous contrast
PRE	Before administration of intravenous contrast
PSC	Primary sclerosing cholangitis
RCC	Renal cell carcinoma
SE	Spin echo
SMA	Superior mesenteric artery
SPEN	Solid and papillary epithelial neoplasm
SPGR	Spoiled gradient echo
STIR	Short-tau inversion recovery
SUB	Subtracted sequence (subtract pre-contrast image from post-contrast image)
T	Tesla
T1	Time required for tissue to recover longitudinal magnetization
T1W	T1 weighted: Sequence in which TE and TR are set to accentuate T1 characteristics of tissue
T2	Time in which tissues lose phase coherence
T2*	T2-star weighted sequence, highly dependent on magnetic field inhomogeneity and the decay of transverse magnetization
T2W	T2 weighted: Sequence in which TE and TR are set to accentuate T2 characteristics of tissue
TE	Echo time
TNF	Tumor necrosis factor
TOF	Time of flight
TR	Repetition time
True FISP	True fast imaging with steady-state precession
TSE	Turbo spin echo
UAE	Uterine artery embolization
VIBE	Volumetric interpolated breath-hold examination