Breast MRI
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Editors

Breast MRI
Diagnosis and Intervention

With 1040 Illustrations

With Forewords by Larry Norton, MD, and Beryl McCormick, MD, Clifford Hudis, MD, and Patrick I. Borgen, MD

Springer
I dedicate this book to my husband, David Charles Perlman MD, my children, Daniel Joseph Perlman and Nina Beth Perlman, and my parents, Robert and Judith Liberman, for their love and support in this and all things.

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To my parents, Jocelyn and James, who inspire me and made dreams come alive, and
To my husband, Giles Hunt, who makes life rich with laughter and love and supports me endlessly, and
To my daughter, Abigail, who makes it all worthwhile

EAM
The book you are about to read is certainly important in itself, as it is an authoritative, practical, and scholarly guide to one of the most rapidly changing and increasingly valuable areas in breast medicine. But its true significance is best appreciated from the long-term historical perspective.

The advances in diagnostics and therapeutics that have transformed our modern world are the results of a revolution in biomedical philosophy that, while starting in the first centuries of the Common Era, is still in progress. This slow but inexorable ascendency of the organ-based medical tradition of the Arabian-Persian-Hebrew schools and consequent decline of the ancient Greek reliance on manipulation of humors (“feed a cold; starve a fever”) has brought functional anatomy into the very center of our thinking. Yet what began with vague concepts of gross organs and organ systems has now progressed into highly sophisticated cell biology, biochemistry, and genetics, even while structure-function linkage has been preserved as the rational core. We have learned to describe phenomena in increasing levels of detail, from the whole tissue down to the level of the single molecule. The process has spun off dramatic improvements in detection, prognostication, and intervention, and promises much, much more.

Seen in this context, the rise of magnetic resonance imaging of the breast is a vital contemporary example of an enduring historical development. The twentieth century saw both the emergence of breast surgery as the first treatment capable of curing some cases of breast cancer and its enhancement by radiation therapy and systemic drug administration. Breast imaging coevolved both to guide the therapeutic hand and to improve the diagnostic hand, thereby vastly augmenting the value of all three treatment modalities. But what we read in these pages is not just a chronicle of advances in the art of visualizing a mass. We are thrust into the middle of a sea change in our ability to assess—simultaneously and non-invasively or minimally invasively—the structure and function of the cells from which cancers arise and are sustained.

Hence, contemporary technology is beginning to provide what twenty centuries of medical progress has sought, a melding of anatomy, physiology, and therapeutics in real time and to strikingly beneficial effect. Fundamental concepts of the normal and cancerous breast are being challenged. Venerable terms like preneoplastic stroma, preinvasive carcinoma, multifocality, and margin assessment are being redefined. Our access to the earliest events in breast disease, the molecular events, is opened wider. Where all of this will lead is, of course, unknowable, but the direction is clear: clearer and deeper and more integrated understanding, all in the service of better management. That is the big picture, and that is what these pages really signify.

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Breast cancer is a major health problem for American women and it accounted for almost 40,000 deaths in 2003. Unlike many other forms of cancer, awareness among women of the risks associated with breast cancer is high and derives from many sources including health education programs promoting screening, extensive media coverage, and first-hand knowledge from friends or relatives with the diagnosis.

Despite this public awareness, our best screening tool, mammography, has a false-negative rate of 10% to 25%, depending on the series. Hundreds of women who participate in screening are falsely reassured that they are breast cancer free each year. Furthermore, mammography has limitations in its ability to accurately establish the extent of disease in the breast for some subsets of women undergoing treatment. For example, it may underestimate the extent of lobular carcinoma in up to 25% of cases. It is in this climate that interest has focused on MRI as an adjunct to mammography.

MRI has been a valuable imaging tool for many parts of the human anatomy since the early 1980s, but it was not widely used for imaging the breast until recently. Fewer than 5 years ago, the US Public Health Service Office on Women’s Health organized a meeting to design and develop a research plan for optimization and clinical evaluation of breast MRI. At the time of the meeting, individual clinicians had research experience within a few specific areas of MRI, but the main conclusions of the meeting were that dissemination of breast MRI into the clinic had been slow, there was an urgent need for a lexicon similar to the BI-RADS™ system developed for reading mammograms, and breast MRI required dedicated breast equipment systems.

As detailed in this textbook, significant progress has been made in the development of MRI for the breast. MRI is now recognized as the most sensitive imaging modality for breast cancer, and it has been shown to provide clarity in many clinical situations in which dense breast tissue is not imaged well with routine mammography or with ultrasound. It has been particularly useful in demonstrating the extent of biopsy-proven cancers, especially invasive lobular cancers and ductal carcinoma in situ, which historically were not well imaged with conventional breast techniques. In such situations, the MRI may be useful in guiding both the surgeon and the patient regarding the appropriate choice of breast conservation versus mastectomy.

The sensitivity of MRI can be a challenge as well as a boon. In women with biopsy-proven cancer, MRIs obtained after wide local excision with pathologically close or involved margins may reveal enhancement that could represent a small volume of tumor that is not clinically relevant and has been sterilized in the past with breast radiation, or it could represent surgical artifact. Research in this area is ongoing and will be critical in broadening the utility of this modality.
The specificity of MRI-enhanced lesions in the breast is moderate. Until recently lesions imaged only on MRI and not on breast ultrasound or mammography were technically difficult to biopsy because ferromagnetic needles (MRI unsafe) could not be used in the localizing process if a magnet was required. Now, with several clinical systems commercially available using nonferromagnetic needles (MRI safe) instead of ferromagnetic devices to localize these lesions and sample tissue, better data will be generated. Also, breast imagers have learned a great deal regarding the timing and sequencing of the images.

At present, the clinical impact of breast MRI is uncertain. In a center with dedicated equipment and equally dedicated radiologists, it is probably useful for women with biopsy-proven breast cancers to exclude additional unsuspected disease. As noted previously, MRI can demonstrate the extent of disease in the breast, thereby assisting in decisions regarding appropriate primary surgery. For women who present with biopsy-proven breast cancer in an axillary node but for whom no primary lesion can be identified through physical examination or mammography, MRI can often direct the surgical team to an index lesion in the breast.

For patients with larger but technically resectable breast cancers who elect neoadjuvant chemotherapy in an effort to convert from mastectomy to breast conservation, MRI is an excellent tool to track the response of the index lesion to chemotherapy and determine if and when a limited surgical procedure is feasible.

In special situations, MRI may be useful for screening. For young women with strong family histories of breast cancer, or who carry a known genetic marker for this disease, mammography may be less useful because of their dense breast tissue. In this situation MRI may provide information that complements conventional screening.

As MRI technology improves and more is learned from clinical trials and retrospective studies, the application and utility of this modality should become clearer. It appears likely that MRI of the breast will play an increasingly important role in the diagnosis and management of selected patients with breast cancer.

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Preface

Breast magnetic resonance imaging (MRI) is creating a revolution in breast diagnosis and intervention. In the last decade, breast MRI has evolved from being an investigational technique to a clinically valuable tool for breast cancer detection and diagnosis. Individuals who perform or refer patients for breast imaging studies need to understand the indications for breast MRI, how to obtain and interpret the images, outcomes of breast MRI in specific scenarios, and how to perform biopsy of lesions detected by MRI only. This book was created to fill that need.

This book is organized into two Parts. Part I, the text, starts with the basics, including a historical overview, technique, how to set up a breast MRI program, the normal breast, the axilla, the breast MRI lexicon, and kinetic analysis. MRI features of benign lesions, ductal carcinoma in situ (DCIS), and invasive breast cancer are discussed in detail. Uses of breast MRI are presented, including high-risk screening, breast cancer staging, assessment of residual disease, MRI after breast cancer treatment, evaluation of silicone breast implants, and other clinical scenarios. The emerging technology of breast MRI spectroscopy is discussed. Specific chapters address MRI-guided interventional procedures, including step-by-step instructions on how to perform MRI-guided needle localization and MRI-guided vacuum-assisted biopsy, and suggestions for challenging cases. The final chapter discusses the potential for breast MRI in percutaneous ablation of breast cancer in the future.

Part II is an atlas of breast MRI. Case examples illustrate the normal breast as well as malignant lesions (distribution of tumor, staging, metastasis, invasive cancer and also have a strong family history of breast cancer and in women who have specific histologies (e.g., invasive lobular) in the index cancer. When breast MRI is used, it should supplement, but not replace, mammography.

For radiologists embarking on a breast MRI program, it may be helpful to start with women who have proven breast cancer, to look for additional ipsilateral and contralateral disease. An essential component of any breast MRI program is the ability to perform localization and biopsy of lesions identified only by MRI. It is invaluable to include mammography technologists experienced at stereotactic biopsy in MRI-guided interventional procedures. Physicians who perform breast MRI should track the results at their own institutions and share this information with their referring clinicians, so that patients can be appropriately counseled. A negative breast MRI does not spare the need for biopsy of a lesion that is suspicious based on mammography or physical examination. It should be remembered that breast MRI is expensive, that some women (e.g., those with claustrophobia, pacemakers, or aneurysm clips) may not be candidates for breast MRI, that there is variability in technique, interpretation, and insurance reimbursement, and that no studies have shown breast MRI to save lives.
This book would not have come to life without the help of many people. Thanks to Robert J. Albano and Margaret Burns at Springer and Barbara Chernow of Chernow Editorial Services for their vision and insight. We thank Hedvig Hricak, MD, our Chairman, for her support. We are grateful to Richard I. DeWitt of Medical Graphics for his meticulous work with the illustrations. We thank Jacqueline Hughes, our office manager, and Jennifer Guido, our research study assistant, for their hard work and dedication. Thanks to Cynthia M. Thornton, mammography supervisor, and Youngduk Paik, Indira Gonzalez, Karen Larson, and Anita M. Sanchez, mammography technologists, for their invaluable contributions to our breast MRI-guided interventional procedures. We thank Richard C. Fischer, MRI supervisor, and C. Gregory Nyman, MRI technologist, who helped us create and maintain our breast MRI program. Thanks to our colleagues in the Departments of Radiology, Surgery, Medical Oncology, Radiation Oncology, Clinical Genetics, and Pathology, with whom we are lucky to work every day. And we gratefully thank D. David Dershaw, MD, Chief of the Breast Imaging Section at Memorial Sloan-Kettering Cancer Center, our colleague, mentor, and friend, who has created an environment that encourages the asking of questions and the seeking of answers.

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Elizabeth A. Morris, MD
Contents

Foreword I by Larry Norton .................................................... vii
Foreword II by Beryl McCormick, Clifford Hudis, and
Patrick I. Borgen ............................................................. ix
Preface ............................................................................ xi
Contributors ..................................................................... xvii

Part I Principles and Practice

1 Breast Magnetic Resonance Imaging: Historical Overview .... 3
   Joo Young Melissa Lee and Elizabeth A. Morris

2 Breast Magnetic Resonance Imaging Techniques .......... 7
   Nola M. Hylton

3 Setting Up a Breast Magnetic Resonance
   Imaging Program ......................................................... 15
   Elizabeth A. Morris

4 The Normal Breast .......................................................... 23
   Elizabeth A. Morris

5 The Axilla ........................................................................ 45
   Joo Young Melissa Lee and D. David Dershaw

6 Breast Magnetic Resonance Imaging Lexicon ............... 51
   Elizabeth A. Morris

7 Dynamic Breast Magnetic Resonance Imaging ............. 79
   Christiane K. Kuhl

8 Benign Lesions ............................................................... 140
   Andrea F. Abramon

9 Ductal Carcinoma In Situ ............................................... 164
   Jennifer H. Menell

10 Magnetic Resonance Imaging of Invasive
    Breast Carcinoma ....................................................... 173
   Lia Bartella and D. David Dershaw

11 The High-Risk Patient and Magnetic Resonance Imaging .. 184
   Laura Liberman

xiii
Assessment of Extent of Disease Using Magnetic Resonance Imaging
Laura Liberman
Assessment of Residual Disease
Elizabeth A. Morris
Posttherapeutic Magnetic Resonance Imaging
Jennifer B. Kaplan and D. David Dershaw
Magnetic Resonance Imaging in Women with Breast Implants
Laura Liberman and Wendie A. Berg
Magnetic Resonance Imaging as a Clinical Tool
D. David Dershaw
Breast Magnetic Resonance Spectroscopy
Robert E. Lenkinski and Rachel Katz-Brull
The Surgeon’s Perspective
Alexandra Heerdt
Magnetic Resonance Imaging Guided Needle Localization
Laura Liberman
Percutaneous Magnetic Resonance Imaging Guided Breast Biopsy
Laura Liberman
Image-Guided Ablation of Breast Cancer
Laura Liberman and Nanette Bracero

Part II Atlas
Normal Breast
1. Breast Density
2. Nipple
Malignant Lesions
1. Distribution of Tumor
2. Staging
3. Metastasis
4. Invasive Carcinoma
5. Ductal Carcinoma In Situ
6. Other Tumors
7. Recurrence
8. Residual
High-Risk Lesions
1. Atypical Duct Hyperplasia
2. Atypical Lobular Hyperplasia
3. Lobular Carcinoma In Situ
4. Radial Scar
Benign Lesions
1. Fibroadenoma
2. Cysts
3. Lymph Nodes
4. Duct Ectasia
5. Papilloma
6. Fibrocystic Changes
Contents

7. Abscess .......................... 448
8. Duct Hyperplasia .................. 449
9. Sclerosing Adenosis .............. 451
10. Adenomyoepithelioma ............ 452
11. Fibrosis .......................... 452
12. Pseudoangiomatous Stromal Hyperplasia ............. 455
13. Skin Lesions ...................... 459
14. Gynecomastia ..................... 462

26 Findings Following Intervention ............... 463
1. Excisional Biopsy .................. 463
2. Needle Biopsy ..................... 482
3. Reconstructive Surgery ............ 484

27 Pitfalls in Analysis of Carcinomas .......... 488
1. Atypical Appearance of Carcinomas .... 488
2. Suboptimal Positioning .............. 495
3. Suboptimal Windowing .............. 497
4. Coil Artifact ....................... 499
5. Metallic Artifact ................... 500
6. Misregistration ..................... 501

Index .................................. 503
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I
Principles and Practice