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Breast Imaging Companion

FOURTH EDITION

Gilda Cardeñosa

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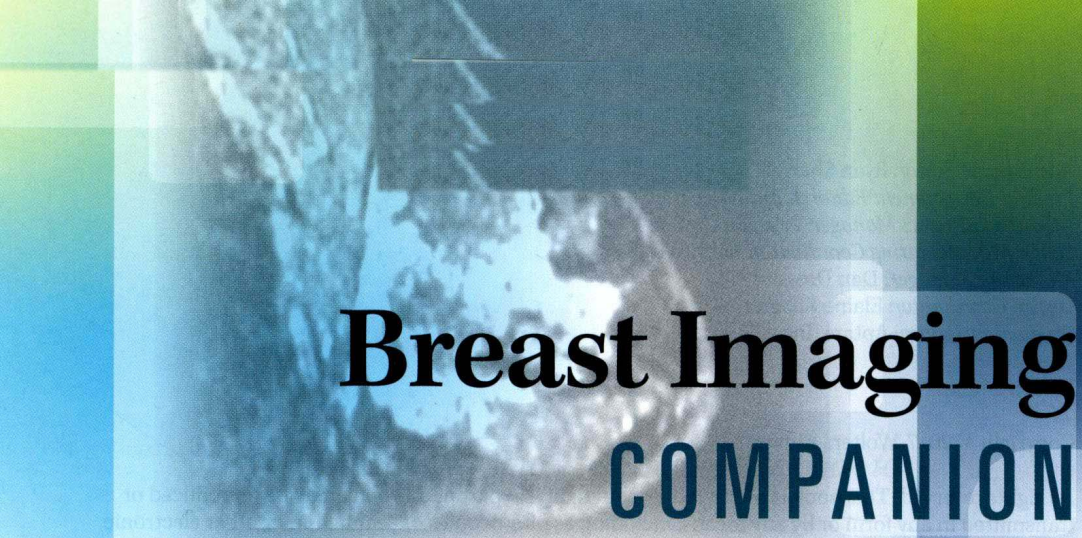

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FOURTH EDITION

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Breast Imaging
COMPANION

I dedicate the fourth edition of this book to

The memory of my mother, Gilda Paniza Cardeñosa (1923–2003),
my father, Ricardo Cardeñosa Barriga, and
to the memory of Dr. Regina T. O'Brien (1921–2007)

Preface

The first edition of this book was written in the 1990s during the pre-digital era. It was basic and focused on mammography and breast ultrasound. Interventional procedures and magnetic resonance imaging of the breast were in their infancy. This edition of the *Breast Imaging Companion* incorporates significant changes aimed at maximizing the benefits afforded by the digital era: the ability to provide the reader with a complete set of images on many of the patients and diseases presented. I have in effect developed a companion to the Companion: critical images are provided in print with a more complete set of images, and when applicable, different modalities available for review in the electronic version of the book.

My goal remains to present the basics of breast imaging in a practical common sense approach so that the reader can develop effective algorithms to use in the interpretation and management of patients with breast-related findings. To this end, I have significantly altered the screening, diagnostic, and MRI chapters so that the basics of interpretation are presented with examples to illustrate all of the concepts discussed. Digital breast tomosynthesis studies are provided in the electronic version of the book so that readers can scroll through studies and familiarize themselves with this modality. The diagnostic evaluations for many of the screening studies presented in the screening chapter are provided in the diagnostic chapter; these include additional mammographic images and, when appropriate, ultrasound and MRI images are available for review in the e-version of the book.

All of the chapters have been updated. Some of the chapters, however, are only available in the electronic version of the book. Since film-screen mammography is now being used in less than 3% of all facilities in the United States, I have limited the QA chapter to issues related to full-field digital mammography. Included among the chapters in the e-version of the book, is a self-assessment chapter with multiple-choice questions some of which are based on images. The answers are provided and, when indicated, explanations are given (or the text discussing the material is referenced). The number of images in the print version is comparable to that in prior editions but now color and some pathology images are included. The electronic version provides the reader with more images, history, and pathology results for many of the patients. To the extent possible I have provided the reader with a complete set of images rather than cherry picking images. Although some of the images presented have been used in prior editions of the Companion, there is no crossover with any of the other books I have written. I hope you find this new edition practical and helpful if you are beginning your rotations in breast imaging or in your day-to-day practice of breast imaging and, most importantly, in taking care of your patients.

Acknowledgments

My sincere thanks to my colleagues Drs. Priti Shah and Tiffany Tucker for whom I have a boundless amount of respect. They are outstanding, yet humble clinicians focused on breast imaging and optimal patient-focused care. It has been my distinct honor to work and learn with them. It is no exaggeration or cliché to say that we learned something new every day.

The technical and clerical staff in the Section of Breast Imaging at VCU Health is unrivaled. My thanks to Joanne Cousins, RTR(M), Lynda Giardini, RTR(M)(BS), and Amy Silva, RTR(M), manager, supervisor, and lead technologist for the Section. To the technologists in the Section all of whom are mammography certified: Courtney Ayala Rivas, Fareeda Connor, Brittany Dumke, Sandra Jessup, Kristin McMahan, Elizabeth Nissly, Rebecca Stuart, and Theresa Taylor, the quality of the images in this book are a testament and tribute to your professionalism. The clerical staff including Jennifer Campbell, Diane Cunningham, Rena Davis, Tekeisha Davis, Tami Freeman, Francheska Hunt, Joyce Jackson, Patricia Lacy, Anthony MacLauren, and Raleigh Poindexter is a vital and integral part of the Section. I extend my deepest gratitude to all of you for your commitment to our patients and the Section.

There are no words to express my gratitude to Mrs. Nancy Cooper. She is an invaluable asset willing to tackle any task, troubleshoot and solve problems always with an inordinate amount of patience, a smile, and good cheer. Over the years we have worked hard and yet during down times shared literary interests and observations on the follies of life.

At Wolters Kluwer, I am indebted to Ryan Shaw for seeing the need for a fourth edition and allowing me to work with no limits on the number of images that could be used in the e-version of the book. I very much value his oversight, editorial suggestions, and ongoing support. To Lauren Pecarich, Priscilla Crater, Elaine Kasmer, Beth Walsh and Dan Dressler at Wolters Kluwer: I sincerely appreciate all of your efforts to make this a world-class publication. At the Aptara Corporation my heartfelt thanks to Mr. Karan Rana and his team for a job well done. It has been a privilege to work with all of you.

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CHAPTER 1

Screening Mammography

GENERAL COMMENTS

KEY FACTS

- Breast cancer is a heterogeneous disease.
- The cause(s) of breast cancer remains unknown consequently prevention is not an option.
- In the United States, the age-adjusted rate of death from breast cancer was 35% lower in 2010 compared with 1989; this is primarily the result of early breast cancer detection.
  - Although some have attributed this decrease to improved treatment, therapy is most effective in saving lives when breast cancer is diagnosed early.
- There is debate as to whether breast cancer is systemic from the beginning or is localized to the breast for variable time periods before becoming systemic.
- If breast cancer is systemic from inception, early detection through mammographic (or any other imaging) screening would have little benefit. However, if some are localized to the breast for variable periods, early detection might represent the most effective way of dealing with the disease.
  - The two-county Swedish screening trial data supports the contention that many breast cancers are localized to the breast for a variable period of time before the development of systemic disease.
  - Under these circumstances, the time to diagnosis becomes critical: The earlier breast cancer is detected the less likely it is to have become systemic.
  - Irrespective of tumor grade and nodal status, patients diagnosed with breast cancers less than 1 cm in size have a 20-year survival rate of approximately 87% (Tabar L, Two-County Swedish trial).
  - Patients with node-negative breast cancers less than 1.5 cm in size have a 20-year survival rate of approximately 84% (Tabar L, Two-County Swedish trial).
- Although prevention of breast cancer is not currently an option, early breast cancer detection impacts overall breast cancer mortality rates significantly (also, available treatment options increase and may be more effective when cancer is detected early).
  - Need to screen a sufficiently large portion of the population to see effects.
  - Need to screen at appropriate intervals.
  - Since the number of prevented breast cancer–related deaths increases with follow-up time, long-term periods of observation (at least 20 years) are needed for the estimates on the absolute benefit from screening mammography to be accurate.
- With the use of mammography breast cancers will be missed:
  - If the threshold for intervention is high (e.g., waiting until a lesion is obviously cancer before doing a biopsy).
  - If the screening intervals are too long.
  - It is generally accepted that breast cancers grow more quickly in premenopausal women, so annual screening mammography is recommended starting at age 40 in women who have an average risk for breast cancer.
  - Tumor sojourn time, defined as the time taken for cancers to go from mammographic preclinical to clinical detectability, is 1.7 years in premenopausal women compared with more than 3.3 years in postmenopausal women.
  - Fast growing cancers are not usually detected through screening or early enough to save lives.
  - If not detected early, slower growing cancers eventually kill patients. Thousands of lives can be saved, when these types of breast cancers are detected early.
- Breast cancer is now most commonly diagnosed through mammographic screening (previously, most breast cancers were diagnosed by patients during breast self-examination).

■ SCREENING TRIALS

KEY FACTS

- Issues to consider in proving screening efficacy.
  - Survival alone is insufficient to establish an alteration in the natural history (or mortality) of breast cancer.
  - Randomized controlled trials (RCTs) with mortality as the end point are needed to overcome biases:
    - Lead time bias: breast cancers can be detected at an earlier date through screening, however, this does not change the time to death.
    - Length bias: there are a disproportionate number of slower growing tumors (better prognosis) diagnosed through screening.
    - Selection bias: self-selected patients (volunteers) may have better outcomes regardless of screening (patients with increased awareness are more likely to be compliant with treatment and follow-ups).
    - Over diagnosis bias: lesions detected through screening are of questionable significance (e.g., low nuclear grade ductal carcinoma in situ [DCIS]) with respect to overall patient mortality.
- RCTs needed to prove efficacy of screening.
  - Trials must enroll enough women to have sufficient statistical power to prove a benefit from screening (e.g., enough women have to die of breast cancer in the control group to prove that the deaths do not occur in the study group). The smaller the difference (benefit) one is trying to prove, the larger the number of women needed to prove that difference.
  - Randomization into control and studies groups should be blinded.
  - Technology, interpretation, and management of findings should be optimal and standardized.
  - Seven RCTs of women starting at age 40 have shown 19% to 32% reductions in breast cancer mortality in women invited to undergo screening compared to the control group not invited to screening.
  - The Canadian National Breast Screening Study is the only trial that failed to show a benefit for mammographic screening in 40- to 49-year-old women. Significant flaws and issues (particularly with respect to randomization), however, have been raised with respect to how this trial was conducted.
  - When considering the results of RCTs it is important to recognize that for the study group, women are invited to undergo screening. Some may choose to not accept the invitation to screening mammography (e.g., compliance is not 100%). These women are still counted as having had screening mammography.
  - Likewise women assigned to the control group are not invited to screening mammography but they can have a mammogram irrespective of the study, and even though a cancer may be detected with mammography, they are counted as not having had a mammogram (crossover).
  - Tabar et al. reported a 63% decrease in breast cancer mortality when reanalyzing the data from the two-county Swedish trial to include only the women who actually underwent screening mammography.
  - Sufficient follow-up to see benefit is needed; in 40- to 49-year-old women at least 10 to 15 years of follow-up are needed before the benefits of screening are seen.
  - It is generally accepted that screening mammography in women over the age of 50 is beneficial (e.g., less women die of breast cancer in the screened population). How logical is it to think that mammography does not work in women under the age of 50? What is magical about 50? What happens to breast tissue when it is 50 years old?
  - Although there is some loss of breast tissue perimenopausally, one cannot predict patient age based on parenchymal patterns: young women can have fatty breasts; older women can have dense tissue. Parenchymal density is not an accurate predictor of a woman's age.
  - With respect to the decreased mortality reported from RCTs for screening mammography keep in mind that all existing trials were done using film screen mammography, while in its infancy.
  - No large scale RCTs have been done to evaluate digital mammography, digital breast tomosynthesis (DBT), breast ultrasound or breast MRI, however, is it logical to suggest that the benefits of early breast cancer detection are dependent on the modality used for the detection? Is it

logical to suggest that the invasive lesions detected with digital mammography, ultrasound or breast MRI are somehow, different from the lesions detected with film screen mammography?

■ SCREENING RECOMMENDATIONS

KEY FACTS

- The American College of Radiology and the Society of Breast Imaging recommend yearly mammograms starting at age 40.
- In October 2015 the American Cancer Society's (ACS) annual recommendations for screening mammography starting at age 40 were changed.
  - The new ACS recommendations are more nuanced and yet you can infer that annual screening mammography should be considered by all women over the age of 40. They advocate, as do many of us, that "women should have the opportunity to become informed about the benefits, limitations, and potential harms associated with regular screening." The new recommendations issued read as follows:
  - Women aged 40 to 44 years: Women should have the opportunity to begin annual screening between the ages of 40 and 44 years. (Qualified recommendation).
  - Women aged 45 to 54 years: Women should undergo regular screening mammography beginning at age 45 years. (Strong recommendation). Women aged 45 to 54 years should be screened annually. (Qualified recommendation).
  - Women aged ≥55 years: Women 55 years and older should transition to biennial screening or have the opportunity to continue screening annually. (Qualified recommendation). Women should continue screening mammography as long as their overall health is good and they have a life expectancy of 10 years or longer. (Qualified recommendation).
  - All women: Clinical breast examination is not recommended for breast cancer screening among average-risk women at any age. (Qualified recommendation).
  - A *qualified recommendation* "indicates there is ***clear evidence of benefit*** of screening but less certainty about the balance of benefits and harms, or about patients' values and preferences which could lead to different decisions."
  - A "*strong recommendation* conveys the consensus that the benefits of adherence to that intervention outweigh the undesirable effects that may result from screening."
- The ACS did not change their existing recommendations for breast MRI as a screening tool.
  - MRI is indicated for women having a 20% to 25% or higher lifetime risk of breast cancer on lifetime risk assessment calculation models.
  - BRCA1, BRCA2 gene carriers, first-degree relatives of gene carriers (who themselves have *not* been tested).
  - History of chest wall radiation (radiation exposure between 10 and 30 years of age and at least 8 years post treatment).
  - Women with syndromes associated with increased risk of breast cancer (e.g., Li–Fraumeni, Cowden, and Bannayan–Riley–Ruvalcaba syndromes).
  - Women at increased risk (e.g., family history, genetic tendency, past breast cancer, atypical ductal hyperplasia [ADH]) should talk with their doctors about the benefits and limitations of starting mammography screening earlier, having additional tests (i.e., breast ultrasound and MRI), or having more frequent examinations.
- The U.S. Preventive Services Task Force (USPSTF) issued new screening guidelines in 2009 that were reaffirmed in 2016:
  - Screening mammography every 2 years in 50- to 74-year-old women and specifically recommended to ***not*** screen 40- to 49-year-old women.
  - These recommendations represent a significant deviation from the use of RCT to establish best practices and were based on computer modeling of 20 different screening mammography regimens using: (a) RCT data on screening mammography as analyzed and summarized by the Oregon Evidence-based Practice Center at Oregon Health Science University, (b) age-specific screening results from the Breast Cancer Surveillance Consortium, and (c) harms considered in the models included radiation exposure, pain during procedure, patient anxiety and other psychology responses, consequences of false-positive and false-negative test results, and over diagnosis of breast cancer.

- Significantly, the researchers did ***not*** consider: (a) peer-reviewed studies assessing benefit of screening mammography (if not RCT); (b) service screening results; (c) studies detailing improvements in screening mammography over time; and (d) peer-reviewed analyses of the cost-benefits of screening mammography compared with other accepted interventions.

■ SCREENING MAMMOGRAPHY: WHO AND WHEN

KEY FACTS

- Asymptomatic women with:
  - An average risk for breast cancer including those with breast augmentation: annually starting at age 40.
  - An increased risk for breast cancer: annually starting by age 30 but not before age 25—this includes those with a known mutation or a genetic syndrome with increased risk for breast cancer and untested women with a first-degree relative with a known BRCA mutation.
  - A 20% or greater risk for breast cancer as determined by breast cancer risk models: annually starting by age 30 but not before age 25 or 10 years earlier than the age at which the youngest first-degree relative was diagnosed whichever is later.
  - A history or chest radiation occurring between the ages of 10 and 30 starting 8 years after the radiation but not before age 25.
  - A biopsy-proven diagnosis of lobular neoplasia (LCIS, ALH), ADH, DCIS, invasive breast cancer, or ovarian cancer: annually starting at the time of diagnosis.
- A screening mammogram can be scheduled without the referral from a physician.
  - Screening facility needs to have procedures in place for referral to a qualified healthcare provider if an abnormal clinical or mammographic finding is present or for those in whom the healthcare provider declines responsibility.
  - Self-referred women: those with no healthcare provider, those who decline having a healthcare provider, or one's in whom the healthcare provider declines responsibility.
  - Self-referring women: schedule on their own initiative and can provide the name of a personal healthcare physician or provider.

■ SCREENING VIEWS: GENERAL COMMENTS

KEY FACTS

- High-quality mammography routinely demonstrates invasive tumors that are 10 mm or smaller in size as well as noninvasive breast cancers (DCIS) commonly presenting with calcifications.
  - High-quality mammography is defined as optimally exposed, high-contrast images with inclusion of a maximal amount of well-compressed tissue, no motion (geometric unsharpness) and free of artifacts.
- Unless there are significant patient-related limitations, do not accept and interpret suboptimal images (e.g., poor positioning, low-contrast, under- or overexposed images, or those with motion).
  - If there are patient limitations, these should be documented by the technologist and described in your report. Efforts made to overcome limitations should also be documented and reported.
- Positioning of the breasts for mammographic studies is critical. Exclusion of breast tissue from the field of view may eliminate the opportunity to diagnose an early, potentially curable breast cancer.
- The inferior and lateral margins of the breasts are mobile; the upper and medial portions of the breasts are fixed in position. During mammographic positioning, natural breast mobility needs to be used to maximize the amount of tissue included in the images.
- In some women, additional views (e.g., exaggerated CCs) may be needed to image all breast tissue in two projections.
  - In addition to positioning, mammographic images must be evaluated for appropriate compression, exposure, contrast, sharpness, noise, artifacts, and film labeling.
- Depending on the size of the breasts, 18 × 24 cm (8 × 10 in) or 24 × 29 cm (10 × 12 in) compression paddle (detector) sizes are available.
  - Women with large breasts may require more than two views of each breast to image all breast tissue. Do whatever it takes to ensure all breast tissue is imaged in the two standard projections.