Vision 20/20: Mammographic breast density and its clinical applications

Kwan-Hoong Ng* and Susie Lau
Department of Biomedical Imaging and University of Malaya Research Imaging Centre, Faculty of Medicine, University of Malaya, 50603 Kuala Lumpur, Malaysia

(Received 29 April 2015; revised 8 October 2015; accepted for publication 15 October 2015; published 18 November 2015)

Breast density is a strong predictor of the failure of mammography screening to detect breast cancer and is a strong predictor of the risk of developing breast cancer. The many imaging options that are now available for imaging dense breasts show great promise, but there is still the question of determining which women are “dense” and what imaging modality is suitable for individual women. To date, mammographic breast density has been classified according to the Breast Imaging-Reporting and Data System (BI-RADS) categories from visual assessment, but this is known to be very subjective. Despite many research reports, the authors believe there has been a lack of physics-led and evidence-based arguments about what breast density actually is, how it should be measured, and how it should be used. In this paper, the authors attempt to start correcting this situation by reviewing the history of breast density research and the debates generated by the advocacy movement. The authors review the development of breast density estimation from pattern analysis to area-based analysis, and the current automated volumetric breast density (VBD) analysis. This is followed by a discussion on seeking the ground truth of VBD and mapping volumetric methods to BI-RADS density categories. The authors expect great improvement in VBD measurements that will satisfy the needs of radiologists, epidemiologists, surgeons, and physicists. The authors believe that they are now witnessing a paradigm shift toward personalized breast screening, which is going to see many more cancers being detected early, with the use of automated density measurement tools as an important component. © 2015 Author(s). All article content, except where otherwise noted, is licensed under a Creative Commons Attribution 3.0 Unported License. [http://dx.doi.org/10.1118/1.4935141]

Key words: BI-RADS, breast cancer, breast density, breast screening, mammography

1. INTRODUCTION

Cappello, an educator by profession had ten previous “normal” annual mammograms until 2004, where she was diagnosed with Stage 3c cancer. Her doctor in her annual checkup felt a suspicious “mass” in her breast just two months after another normal mammogram in November 2003. During her investigations about why the mammogram had been reported normal, she found out why her mammograms had missed the breast cancer earlier—she had dense breasts. Cappello’s experience led to the birth of the women’s advocacy movement, Are You Dense,¹ which has powerfully argued that women have a right to be told their breast density following a mammogram, and that they should be informed of their screening choices if they do have “dense” breasts.

It is now widely accepted that breast density is a strong predictor of the failure of mammography screening to detect breast cancer and is a predictor of the risk of developing breast cancer, and that risk of breast cancer is 4–5 times greater in women with dense breast tissue in 75% or more of their breasts compared with those with little or no dense breast tissue.²–⁴ What is less well-known to the wider community is breast density’s relationship to the aggressiveness of tumors,⁵–⁸ risk of repeat surgery,⁹,¹⁰ and its relationship to the benefits of chemo-preventative drugs such as tamoxifen,¹¹–¹⁵ as well as its importance in reliably estimating mean glandular dose.¹⁶–²²

Clearly, this is a rich and seemingly ever expanding area of translational clinical research. However, the practice of informing women that they have dense breasts has remained controversial. The question is why.

We believe that there are two main drivers of this controversy. First, there has been the perception that there are few alternatives that can be offered to the dense-breasted women, and no breast cancer risk models including breast density have been widely accepted. However, the adjunctive screening options have now improved. For example, tomosynthesis is showing promise and appears to be likely to improve screening through reduced call-backs and increased cancer detection.²³–³³ However, tomosynthesis seems unlikely to be able to deal with extremely dense breasts effectively,³⁴,³⁵ and there are lingering dose and reading time concerns.²³,³⁶,³⁷ Ultrasound has strong proponents,³⁴,³⁵,³⁸–⁴² and has been used for many years in Asia to screen dense-breasted women, but concerns persist over false-positives and the time taken to image and read the results. Some of these concerns may be alleviated with the use of new automated whole-breast ultrasound systems.³⁵,⁴¹,⁴³–⁵⁰ There is also strong support for MRI,⁵¹–⁵⁸ but there remain concerns about the use of contrast agents, its cost and its availability, although accelerated breast MRI sequences are being trialed.⁵⁹–⁶⁹ Finally, molecular breast imaging is being touted for extremely dense breasts,⁷⁰–⁷⁸ although concerns persist about dose and contrast; nonetheless, these concerns are starting to be addressed.⁷⁰,⁷⁶,⁷⁸,⁷⁹