Winter | 2022

SBINEWS

The Member Newsletter of the Society of Breast Imaging

INSIDE THIS ISSUE:

New SBI Fellows, inducted December 2021

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OUR SBI MISSION:
To save lives and minimize the impact of breast cancer

OUR SBI VALUES:
Patient-centered and evidence-based care

Excellence in education

Scientific integrity

Collaboration and collegiality

Respect for diversity and inclusiveness

Emily Conant,
MD, FACR, FSBI
President of the SBI

By this point we had all hoped to not be talking about the pandemic. Unfortunately, with new variants and increasing cases across the United States, we are still in COVID-19 limbo. I'm sure many of you attended the Radiological Society of North America (RSNA) annual meeting, either in person or remotely, and saw the huge impact that COVID-19 has had not only on our networking but also on the topics of discussion. Although in-person attendance at the RSNA meeting was estimated at less than half of prior recent attendances (approximately 19,000 attendees this year versus 52,000 attendees in 2019), virtual engagement was robust and the quality of presentations was superb. Of course, many presentations focused on COVID-19's impact on our imaging world and work-life balance as well as what we are learning from the pandemic to improve our future.

Notably, a large number of RSNA meeting abstracts and presentations discussed using artificial intelligence applications in multimodality breast imaging to decrease variability in interpretations, improve workflow efficiency, integrate image-derived data to improve breast cancer risk assessment, or do all of the above. While many of these applications were framed around workforce staffing and efficiency, the simultaneous improvement in patient outcomes was emphasized throughout the meeting.

As we look forward to the new year and our spring SBI meeting in Savannah, Georgia, the SBI Education Committee is working to further refine the hybrid (virtual plus in-person) format to improve accessibility while elevating our dynamic scientific and educational offerings. Please save the dates of May 16 through 19, 2022. Hopefully those of us who wish to attend in person will be able to do so!

Finally, I'd like to call your attention to the continued and growing coverage of randomization irregularities in the two prospective and pivotal Canadian National Breast Screening Studies (CNBSS). An editorial by Dr. Martin Yaffe and colleagues, published online November 23, 2021, in the *Journal of Medical Screening*, summarizes the concerns surrounding errors in both trials' design and conduct. The data from the two CNBSS trials have been used in meta-analyses to determine breast cancer screening guidelines, even though the CNBSS' results, which showed no benefit from routine screening, ran counter to the results of other randomized trials. I'm sure we will have more information on these important findings as additional data are made available. Stay tuned.

I hope you all have a healthy and happy holiday season and that the new year brings new opportunities and insights as we hopefully progress beyond the pandemic. Thanks to all for your interest and commitment to our dynamic SBI!

Best regards,

Emily F. Conant MD

Emily Conant, MD, FACR, FSBI
President, Society of Breast Imaging

Editor's Note

By Vilert Loving, MD, MMM, FSBI

Vilert Loving, MD, MMM, FSBI

A new year begins. Like many people, I view the flipping of the calendar with a sense of excitement. Although largely symbolic, the fresh beginning suggests that there are opportunities to start new personal and professional projects, reinvigorate ongoing projects, and tackle any challenges that may be laid before us.

As a field, breast imaging has many ongoing challenges: the persistent breast cancer screening debate, the incorporation of new technologies into busy practices, workforce shortages, ubiquitously tight budgets, burnout, and of course, the COVID-19 pandemic. While these challenges present sources of mental stress, with the turn of the new year I often choose to view them as sources of inspiration. Viewing hurdles with a clear mindset may open the door to an as-of-yet unnoticed solution.

In this edition of *SBI News*, we present a diverse array of topics relevant to all aspects of breast imaging. The Radiological Society of North America annual meeting in December presented research and innovations in artificial intelligence, risk assessment, magnetic resonance imaging, and functional imaging, and Dr. Nidhi Sharma expertly curated some of these presentations. Similarly, Dr. Elizabeth Krupinski summarizes several papers covering breast radiology physics. Research and innovations occur globally in breast radiology, and the European Society of Breast Imaging (EUSOBI) Young Club Committee provides us with an overview of the EUSOBI 2021 annual meeting. Drs. Anam Salman and Anita Mehta introduce us to liquid biopsy and how it may complement our current diagnostic tools for breast cancer. On the humanistic side, Dr. Eric Rosen, FSBI, takes us along his profound existential journey touching upon the transient nature of life. For technologists, Louise Miller, RT(R)(M)(ARRT), CRT, FSBI, FNCBC, gives practical tips to preserve one's health and avoid repetitive stress injuries with optimal ergonomics. For breast radiologists at any career level, Dr. Amy Patel challenges us to get involved with advocacy efforts to support our field and patients. In counterbalance, Dr. Mary Scott Soo introduces the Late Career and Retirement Column, offering advice for radiologists approaching the late stages of their career and retirement. Drs. Sophia O'Brien and Amina Farooq give us a nice overview of BI-RADS 3 lesions, a nuanced and often mistakenly used assessment in breast radiology. Finally, to remind us of breast radiologists' impact, Dr. Hannah Perry delivers the story of Ms. Huria Patwardhan, a breast cancer survivor who offers advice to breast radiologists and breast cancer patients.

With the turn of the new year, my hope is to provide you, our reader, with a breadth of topics that will inspire you to seek new challenges to overcome. Perhaps we will introduce an aspect of breast imaging that sparks your interest or a previously unnoticed pain point that warrants your investigation. Now is the time to set those New Year's resolutions! Why not incorporate *SBI News* topics into those goals?

As always, if you have suggestions for improvement or would like to guest author an article, I would love to hear from you: vilert.loving@bannerhealth.com.

EUSOBI 2021 Online Meeting

By the EUSOBI Young Club Committee: Maria Adele Marino, MD; Paola Clauser, MD, PhD; Elisabetta Giannotti, MD; Doris Leithner, MD; Simone Schiaffino, MD; Thiemo van Nijnatten, MD, PhD; Mirjam Wielema, MD

This past October, Breast Cancer Awareness Month, the European Society of Breast Imaging (EUSOBI) annual scientific meeting took place virtually. In four sessions during the whole month, a selection of international experts shared their knowledge on the latest updates and controversies in breast imaging. Despite the virtual nature of the conference, particular attention was paid to interactivity by adding expert discussion panels at the end of each session and encouraging active audience participation.

EUSOBI President Prof. Fiona Gilbert and Scientific Committee Chairperson Dr. Ritse Mann opened the congress on October 4, 2021, with a special session dedicated to breast cancer screening.[1] Inevitably, the impact of the COVID-19 pandemic on breast cancer screening was the focus. The pandemic delayed screening programs everywhere in the world, highlighting the importance of improving the organization of screening programs. Facilities should ensure that prompt evaluation of symptomatic patients and screening of high-risk patients are available, even during a pandemic. With the introduction of new approaches and modalities in screening, a discussion of the best outcome measures to evaluate the effectiveness of screening programs was timely.[2]

The second session, on October 12, 2021, focused on treatment. Recent international studies showed the value of contrast-enhanced magnetic resonance imaging (MRI) of the breast in the preoperative evaluation of in situ and invasive cancers.[3,4] These studies also underlined the importance of using a multidisciplinary approach to translate imaging information into personalized therapeutic plans. The focus of the second part of the session was on the advancement of minimally invasive methods to treat local and metastatic breast cancer. This session demonstrated how radiologists can have a therapeutic role that is not limited to biopsy. Biopsy can be an excisional tool (for example, for lesions of uncertain malignant potential), but radiologists can use further techniques to achieve targeted, minimally invasive therapy. In this context, ensuring a dialogue with medical oncologists, surgeons, and radiation oncologists and involving the patient as much as possible in clinical decision-making are fundamental.[5,6]

The third session offered insights into artificial intelligence (AI) in the field of breast imaging. AI could potentially have an impact on several levels, from risk prediction to screening, as well as on staging and therapy guidance.[7,8] However, technical, economic, and legal issues related to AI in the clinical workflow should be taken into account.[9] Keeping in mind the clinical and legal implications involved in safely introducing AI in clinical practice, the overall opinion of breast radiologists toward AI and its potential is very positive.

The last session was dedicated to two hot topics: abbreviated breast MRI[10] and contrast-enhanced mammography.[11] The focus of the first part of the session was on clarifying the definitions of the short protocols, abbreviated MRI and ultrafast MRI, as *abbreviated MRI* is an umbrella term. While abbreviated protocols lack part of the multiparametric information and should therefore not be applied in all clinical settings, they might be ideal in a screening setting. The advantages and disadvantages of contrast-enhanced mammography were then discussed. While this examination is fast and well accepted by patients, more data and larger studies are needed to confirm its future clinical role. Larger analyses to confirm its high sensitivity and negative predictive value are needed.

In 2021, two young researchers were awarded Young Physician-Scientist Grants: Dr. Roxana Pintican, from Romania, for work on the role of ultrasound in the evaluation of lymph nodes in high-risk patients with breast cancer, and Dr. Sanjivanee Ingole, from India, for a study on breast vascular calcifications as a cardiac health marker.

To support young researchers, EUSOBI started a new funding program. The EUSOBI Young Club (EYC) Committee awarded funding for two projects: "Multi-parametric Breast Ultrasound Imaging as a Potential Biomarker for Breast Cancer," by Dr. Anna Potempa, Baden, Switzerland, and "Triaging Women From MRI to Mammography to Adapt Screening to Changes in Breast Density Using Artificial Intelligence," by Dr. Bas van der Velden, Utrecht, the Netherlands. The awarded researchers will present their results during the 2022 EUSOBI annual meeting in Malmö, Sweden.

The EYC held the third edition of the "Meet the Expert" session to allow young radiologists and residents to connect with experts in the field. This large series of events ended with an EYC-sponsored multidisciplinary session. An international group of young experts in medical oncology, radiation therapy, oncoplastic surgery, and pathology joined the EYC Committee and the audience in an engaging case-based discussion. This was the kickoff event for the 2022 EYC webinar series, which will be dedicated to the multidisciplinary approach to breast cancer diagnosis and therapy. The aim of this upcoming series will be to help breast radiologists prepare for interdisciplinary communication and to obtain the best clinical practice for our patients.

Lectures from the EUSOBI virtual meeting are still available online. More information is available at https://www.eusobi.org/congress/.

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WELLNESS COLUMN

Land Ho!

By Eric Rosen, MD, FSBI

Eric Rosen, MD, FSBI

O, mystic Land of Some Day,
Behold our sails spread wide,
As toward thy azure mountains
'Neath softest skies we glide;
"Land ho!" the lookout's calling,
Down oars and sails are falling —
Forever, just ahead!

"Some Day Land" by James Edwin Campbell

As we ease into December with shorter and darker days in our physical world, I am drawn inwards to contemplative self-reflection and introspection. I find myself thinking about the events of the past year while focusing on accomplishments, challenges, relationships, and intentions for the next year. This has been a trying past year with sad news in abundance. It is harder than I remember to see a clear path moving forward. I also realize that there has been a more gradual shift of my perspective, akin to a paradigm shift. I no longer see my life as the beginning of a long unfinished book; rather, now I see it as at least half finished and with a definite end. My parents, both in their 80's, are currently facing medical situations that are dire but, at least for now, manageable. I cannot help but wonder if this will be their last winter. When I think about their deaths, my first reaction is to turn away. Unlike when I was younger, I find this topic increasingly difficult to think about.

This mental shift reminds me of a voyage sailing on the ocean. At the outset, there is excitement about the journey and concerns are focused on things like planning the route, anticipating the weather, and logistics. Thoughts about the destination are few and far between; the focus is on more pragmatic and immediate concerns. In the middle of an ocean, it is hard to contemplate an invisible, far-off destination. However, when land finally appears on the horizon, the reality of reaching the destination becomes clear. The land I have sighted on the distant horizon is shrouded in mist but gaining in visibility as I approach. I now appreciate, in a very personal way, the finiteness of everything. We usually don't talk about death, and I am wondering why. The answer is probably fear with a heavy dose of denial.

Well, I have been thinking about death this year. How could I not? One thing I am immediately reminded of is how lucky I am. At 56 years old, I (and my family) have been remarkably healthy. Up to this point, my most intimate personal relationships with death have been with my pets. Hopefully some of you have read *The Art of Racing in the Rain* and understand. I remember feeling sad when my first dog, Ella, died, but somehow the details of my grieving seem blurry. Maybe this is part of our long-term physiologic response to grief, so that we can proceed with life.

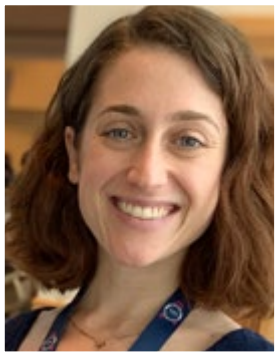
This winter feels different. I know death and loss are painful, and no matter how ubiquitous, we all respond to the stages of grief and loss in our own unique way. Right now I have decided to focus on the present and to be thankful. I am thankful for all the love and time I have received from my parents. Something I've noticed is that anticipatory reflection on death leads to clarity and insight about what is truly important. This is the wisdom that comes from life that can also be filled with pain and suffering. I am able to forgive, apologize, trust, and let go in a way that I was unable to do when I was younger. Perhaps experiencing great loss will ultimately enable me to fully blossom and achieve my best self. Up until very recently, I felt very comfortable in my familial role of son, brother, cousin, and even uncle. Spouse and father are both works in progress, but I can attest that the love and responsibility of marriage and parenthood similarly and continuously challenge me toward self-improvement. I know there is pain and suffering ahead, and I am scared because my parents provide a buffer from my own mortality. When they are gone, that is no longer true. I know I will get through it. I am surrounded by supportive, loving people. My goal and wish, however, is to channel the energy of loss and grief into becoming closer to my ideal self so that I can shower those I encounter with the kindness, generosity, and compassion that I have been so fortunate to receive. This, I think, is the way I can honor my parents, showing the wisdom that can be achieved through loss.

I want to thank everyone who has taken the time to read this wellness column over the past 4 years and especially everyone at the SBI who has supported this newsletter and forum. My hope is that I have resonated with the readers and provided some helpful information along the way. I am wishing you all a peaceful new year.

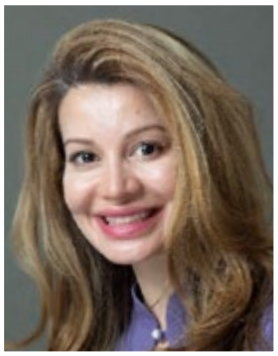
MEMBER-IN-TRAINING COLUMN

Trainee Pearls: Review of the BI-RADS 3 Lesion

By Sophia O'Brien, MD; Amina Farooq, MD



Sophia O'Brian, MD



Amina Farooq, MD

The ACR Breast Imaging Reporting and Data System (BI-RADS) was created in 1993 to improve outcomes monitoring and to standardize breast imaging interpretation, recommendations, and reporting language. Now in its fifth edition, the BI-RADS manual groups mammographic, sonographic, and magnetic resonance imaging features into six categories (Table 1). Perhaps the most nuanced, contested, and difficult-to-use category is BI-RADS 3, the probably benign lesion.

Table 1. BI-RADS Assessment Categories[1]

BI-RADS category	Risk of malignancy
0: Incomplete	0%
1: Negative	0%
2: Benign	0%
3: Probably benign	≤ 2%
4: Suspicious for malignancy	4A: > 2% to ≤ 10% 4B: > 10% to ≤ 50% 4C: > 50% to < 95%
5: Highly suggestive of malignancy	≥ 95%
6: Known biopsy-proven malignancy	100%

A BI-RADS 3 assessment indicates a lesion with an estimated chance of malignancy of 2% or less and triggers an imaging surveillance management recommendation to evaluate for stability over time. The purpose of this category is to decrease unnecessary biopsies while still maintaining appropriate sensitivity for early-stage malignancy. This assessment can only be given after a finding has undergone complete diagnostic workup. A BI-RADS 3 assessment is never given on a screening examination. (Remember, screening examinations can receive only a BI-RADS 0, 1, or 2 assessment). Additionally, in most instances, a BI-RADS 3 assessment should be given only when no prior imaging is available to establish the stability of a finding.

The suggested follow-up for a BI-RADS 3 lesion is diagnostic imaging at 6 months, 12 months, 24 months, and, optionally, 36 months, as long as the lesion remains stable on imaging. The imaging at 12 and 24 months should include bilateral mammography to maintain the patient's annual screening schedule. If the BI-RADS 3 lesion demonstrates stability at 2 years, it is considered benign and downgraded to a BI-RADS 2 assessment. If at any point during follow-up the BI-RADS 3 lesion demonstrates characteristics clearly in keeping with a benign lesion, it can be downgraded to a BI-RADS 2 assessment at that time. If at any point during follow-up the BI-RADS 3 lesion demonstrates suspicious imaging characteristics or a suspicious change, such as interval growth, it should be upgraded to BI-RADS 4 with a recommendation for tissue sampling. If at any point during follow-up the BI-RADS 3 lesion resolves completely, it should be given a BI-RADS 1 assessment.

In some special circumstances a lesion is assessed as BI-RADS 3 but given a recommendation for initial follow-up sooner than 6 months. For example, a clinically suspected hematoma is a BI-RADS 3 lesion, which is typically recommended for follow-up at four to eight weeks to assess for expected evolution.

Tables 2 and 3 list examples of BI-RADS 3 lesions on diagnostic mammography and ultrasonography, respectively. The BI-RADS 3 classification can also be used in magnetic resonance imaging but is less established in that modality and will not be covered in this article.

Table 2.

Examples of BI-RADS 3 Lesions on Mammography
Solitary group of round or punctate calcifications
Noncalcified, circumscribed, solid, round or oval, solitary mass
Focal asymmetry without calcifications or architectural distortion and no sonographic correlate

Table 3.

Examples of BI-RADS 3 Lesions on Ultrasonography
Classic-appearing fibroadenoma (solid, oval, circumscribed, parallel, hypoechoic mass without posterior features or with minimal posterior acoustic enhancement)
Findings suspected to represent fat necrosis or hematoma
Asymptomatic, isolated, complicated cyst

In Figures 1 through 4, we review classic BI-RADS 3 lesions and a lesion that should not be characterized as BI-RADS 3.

1

Figure 1. Classic fibroadenoma on ultrasonography. A 27-year-old woman presented with a left breast lump felt on her first-ever breast self-examination. Since the patient is a woman younger than 30 years, mammography was deferred. Focused sonographic evaluation of the left breast at the area of palpable concern revealed an oval, parallel, circumscribed, hypoechoic mass without definite posterior features, measuring up to 2.2 cm, favored to represent a fibroadenoma and appropriately assessed as BI-RADS 3. If the lesion were definitely new or enlarging, it would have been given a BI-RADS 4 assessment with recommendation for biopsy.

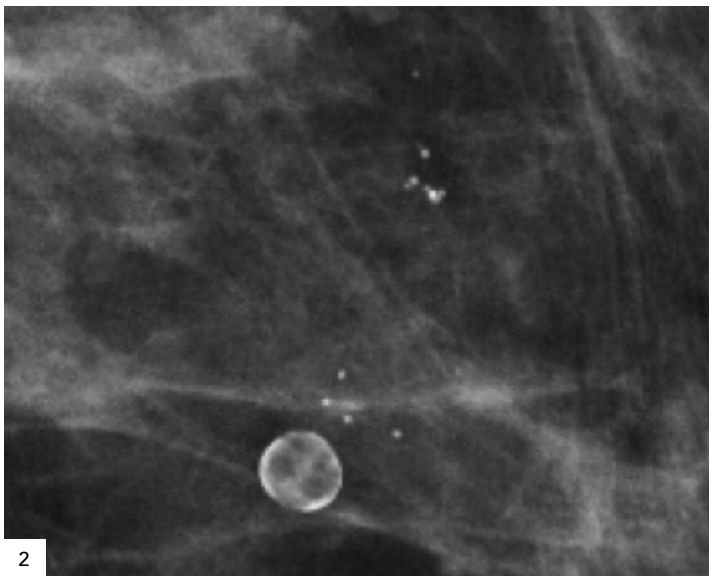


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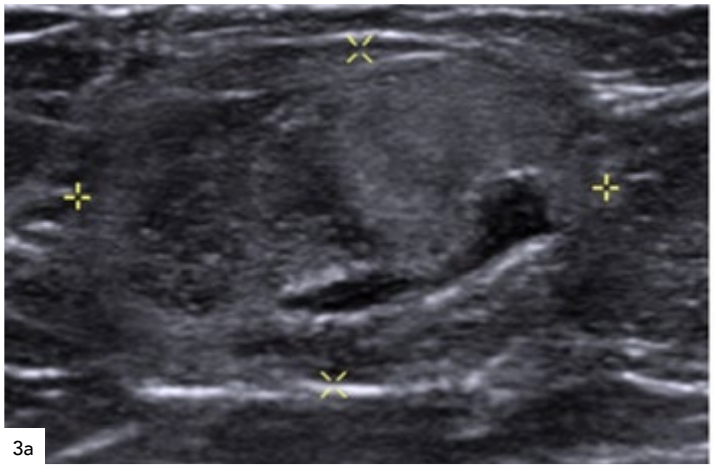
Figure 2. Grouped round and/or punctate calcifications. Two groups of round and punctate calcifications were seen on screening mammography in a 52-year-old woman. The calcifications were further evaluated on diagnostic mammography with magnification views (image shown here) and appropriately assessed as BI-RADS 3. An adjacent oil cyst (a lucent, circumscribed lesion with peripheral calcifications) is consistent with fat necrosis, a BI-RADS 2 finding.



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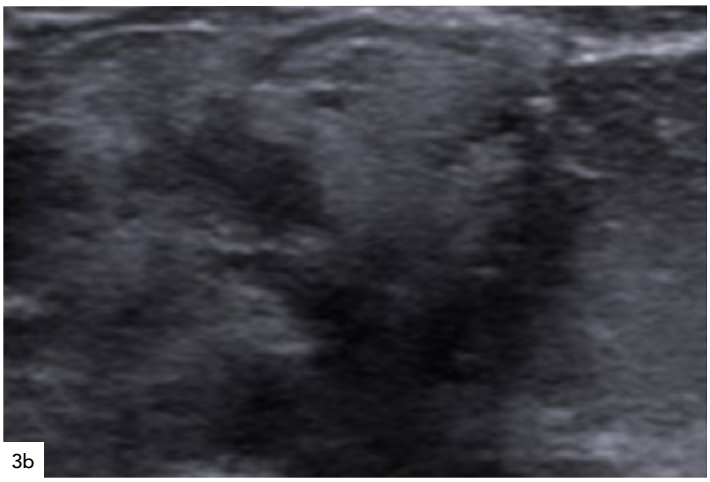

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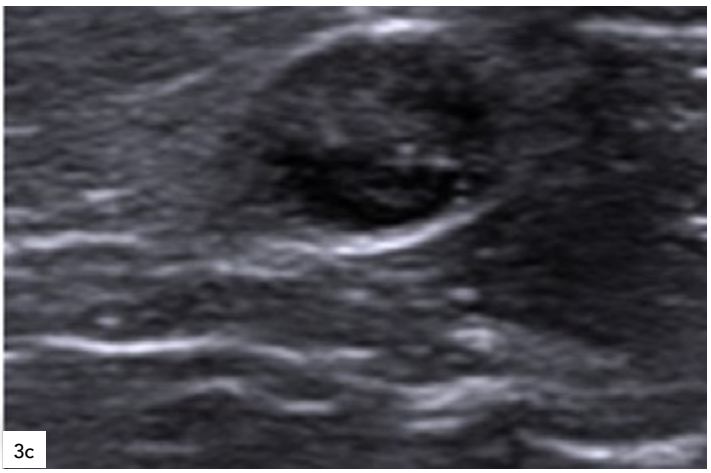

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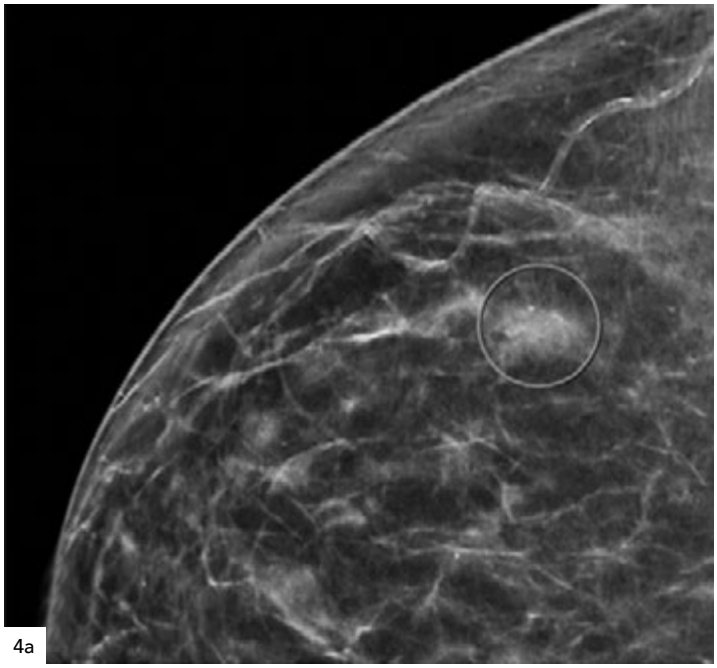
Figure 3. Evolving hematoma. The images show the sonographic evolution of a hematoma in a 49-year-old woman. (A) A 3.1-cm complex cystic and solid mass is seen at the site of recent trauma and new palpable abnormality. The lesion was favored to represent a hematoma and appropriately assessed as BI-RADS 3. (B) Sonographic follow-up 3 weeks later revealed a complex cystic and solid lesion, slightly decreased in size from the previous image, in keeping with evolving hematoma. (C) Sonographic evaluation 9 months later revealed a small complicated cyst, much decreased in size, in keeping with evolution of hematoma/fat necrosis. The lesion was downgraded to BI-RADS 2 with a recommendation for the patient to return to annual screening mammography.



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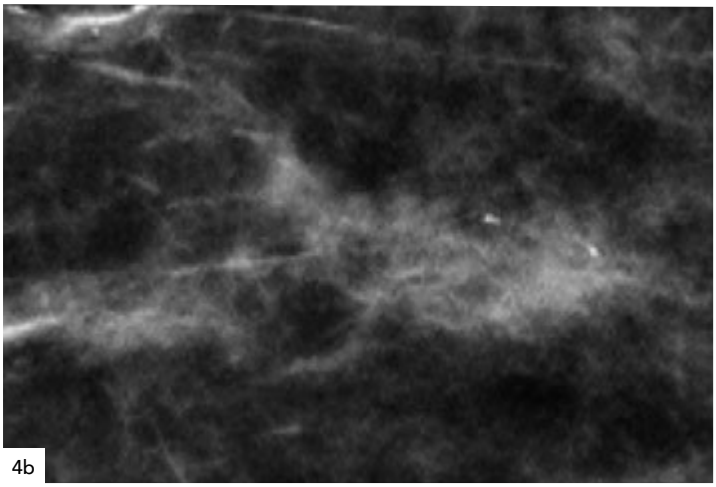

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Figure 4. Developing asymmetry with associated calcification. This is not a BI-RADS 3 lesion and tissue sampling is needed. Screening and subsequent diagnostic mammography in a 55-year-old woman revealed a new focal asymmetry in the upper outer quadrant of the right breast with associated calcifications, shown on the (A) right craniocaudal view (circle) and (B) right craniocaudal magnification view. No sonographic correlate was found. The lack of abnormal findings on ultrasonography does not make the mammographic abnormality less suspicious. A focal asymmetry on a baseline or screening mammogram without comparisons can be given a BI-RADS 3 assessment after diagnostic workup. However, a new or enlarging focal asymmetry that cannot be attributed to summation artifact is best described as a developing asymmetry and should be assessed as BI-RADS 4 after diagnostic workup with recommendation for biopsy. A focal asymmetry with associated calcifications (as in this case) or architectural distortion should also be given a BI-RADS 4 assessment. Stereotactic-guided right breast core biopsy was performed, and pathologic analysis revealed ductal carcinoma in situ.

Teaching Points

A BI-RADS 3 assessment can be given only after complete diagnostic workup of a finding. Never use BI-RADS 3 on a screening mammogram. (Remember, screening mammograms can only be given a BI-RADS 0, 1, or 2 assessment.)

BI-RADS 3 lesions are probably benign, with an **estimated 2% or less chance of representing a malignancy.**

The typical follow-up of a BI-RADS 3 lesion that remains stable is **repeat diagnostic imaging at 6 months, 12 months, and 24 months.** If the lesion remains stable at 24 months, it is downgraded to BI-RADS 2 (benign).

At any point during follow-up, a BI-RADS 3 lesion **can be downgraded to BI-RADS 2 or upgraded to BI-RADS 4** on the basis of imaging appearance and/or change over time.

A BI-RADS 4 lesion is not downgraded to BI-RADS 3 if there is no corresponding finding on another modality (such as no sonographic correlate of a mammographic abnormality or vice versa). **The absence of abnormal findings in one modality should not delay tissue sampling of a suspicious finding seen in another modality.**

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EUSOBI 2021 Online Meeting (continued from page 5)

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TECHNOLOGISTS' COLUMN

The Cost of Poor Positioning: Avoiding Workplace Injuries by Using Proper Positioning Techniques

By Louise C. Miller, RT(R)(M)(ARRT), CRT, FSBI, FNCBC

Louise C. Miller, RT(R)(M)(ARRT), CRT, FSBI, FNCBC

Since the inception of the Mammography Quality Standards Act and accreditation processes over 30 years ago, poor image quality, predominantly secondary to poor positioning, continues to be the primary reason for accreditation failure. Moreover, poor positioning decreases cancer detection sensitivity by 18.1%.[1] Consistent, reproducible, efficient, proficient, and ergonomically sound techniques produce far superior images.[2] Many technologists are still practicing outdated techniques because of the few opportunities for technologists to receive updated, standardized hands-on training that emphasizes the need to use appropriate body mechanics. Despite every technologist's best intention, incorrect positioning techniques are passed on to others. Technologists increasingly report positioning-related injuries that cause them to lose work time and sometimes their jobs, exacerbating an existing shortage of qualified mammography technologists. Skilled mammographers are hard to find and often hard to keep because of highly competitive salaries and a shortage of younger technologists choosing mammography as older mammographers retire.

Consequently, it is important to consider practical ways to ensure that mammography technologists stay healthy and avoid positioning-related injuries. Most injuries related to general radiologic technology are repetitive motion injuries (RMIs).[3] Many studies have investigated the effects of these injuries on ultrasonographers. Ninety percent of clinical sonographers report work-related musculoskeletal disorders. These disorders are the most frequently reported cause of restricted or lost work time, which can cost employers an astonishing $120 billion each year in direct and indirect costs.[4]

Although no data specifically related to mammography positioning and RMIs have been published, it is safe to assume that these injuries will affect mammographers who do not practice positioning techniques that are ergonomically sound. It is unfortunate that there is no real standard for the teaching and use of correct body mechanics. If this is not taken into consideration in the training of future technologists, this trend could continue, as it has with ultrasonographers. According to informal surveys, over 50% of mammographers feel that they have work-related pain and have incurred injuries related to positioning. The good news is that many ergonomically incorrect techniques can easily be changed!

Although some injuries are caused by a patient inadvertently grabbing or falling on the technologist, analysis shows that the most common causes of potential injuries in mammographers fall into two categories: RMIs and ergonomically incorrect use of the core muscles and extremities.

Repetitive Motion Injuries

A technologist positions breasts hundreds of times a week and thus repeats each step or movement over and over. If the technologist does not employ proper positioning techniques, these repeated movements can lead to pain and injury. The sites that most commonly develop RMIs are hands, wrists, and shoulders. Simple changes in hand and wrist position are illustrated in Figures 1 through 4.

1

Figure 1. Correct hand and wrist position for the craniocaudal (CC) view. The hand, wrist, and forearm are straight and in the appropriate position. The base of the thumb is anchoring the breast, which will help ensure visualization of more posterior, superior breast tissue and a higher probability of visualizing the pectoralis muscle.

2a

2b

Figure 2. Incorrect hand and wrist position for the CC view. Note the separation of the thumb from the index fingers and flexion of the wrist. This position can contribute to repetitive motion injuries and also may exclude visualization of posterior, superior tissue and decrease the possibility of visualizing pectoralis muscle, which should be seen on approximately 50% of all CC views.

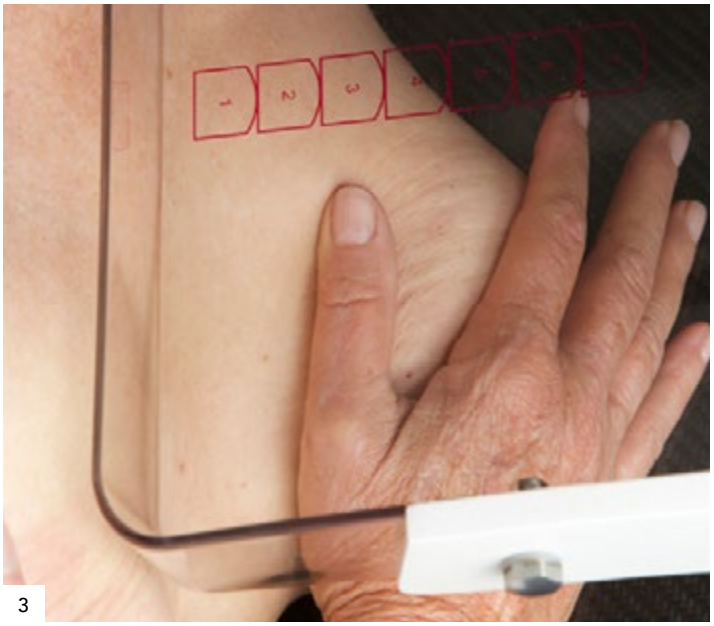

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Figure 3. Correct hand and wrist position for the mediolateral oblique (MLO) view. The technologist's hand should be palm down, with minimal flexion, using the base of the hand to stabilize the breast and help ensure visualization of the inframammary fold. This position helps support the breast in the up and out position as compression is applied.

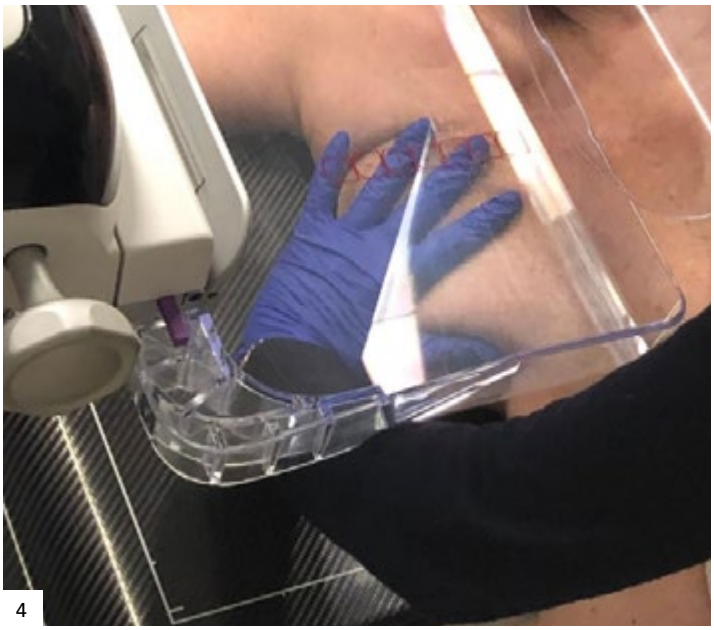

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Figure 4. Incorrect hand and wrist position for the MLO view. Note the extreme flexion of the technologist's wrist and hand. Placing the thumb in the inframammary fold can cause unnecessary skin folds in the inframammary fold and will not support the breast as compression is applied.

Ergonomically Incorrect Use of Core Muscles and Extremities

Whenever possible, the technologist's body should be upright while positioning a patient for the craniocaudal and mediolateral oblique (MLO) views (Figures 5 through 8). Good posture is essential to avoid unnecessary and potentially harmful bending of the back and neck. Whenever possible, elbows should not be raised above shoulder level.

5a 5b

Figure 5. Correct technologist core position for the CC and MLO views. For both views the technologist should approach the patient from the medial side of the breast being imaged.

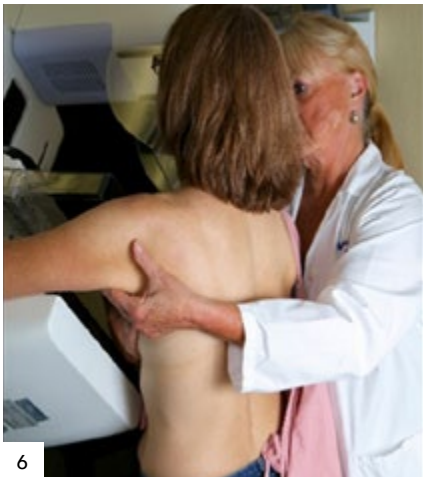

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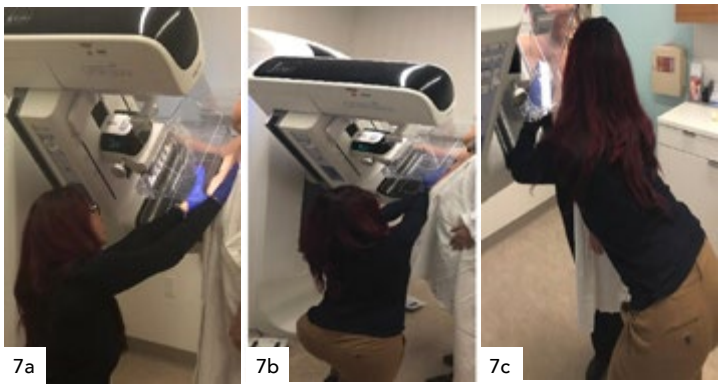
Figure 6. Correct technologist core position for the MLO view.



7a 7b 7c

Figure 7. Incorrect technologist core position for the MLO view. Note the incorrect back position causing excessive flexion and extension of the spine. The elbows are extended above shoulder level. All of these incorrect positioning methods can contribute to repetitive motion injuries.

Other Considerations

Sitting for MLO Views?

Many technologists, especially those who are very tall, report that sitting on a stool to obtain MLO views is beneficial. Sitting prevents them from having to bend around the tube head to visualize the breast while positioning. Each technologist should consult a physician or a qualified physical therapist about the position that will work best to prevent pain and avoid injury. If it is absolutely necessary for the technologist to use the seated position, special

care should be given to shoulder movement because from this position the technologist will have to repeatedly elevate the hands, arms, elbows, and shoulders while positioning the patient. Repeated elevation of the shoulders is one of the major causes of RMI and should be avoided when possible. Therefore, sitting to perform positioning is not generally recommended because of the ergonomic issues described in this article and should not be considered a standard for patient positioning. The recommended standard method results in a more efficient patient examination and experience with minimal effort on the technologist's part.

Technologist and Patient Size Variability

Due to the wide variety of patient and technologist body types and flexibility, not every technologist can position each patient using the same technique. Technique modifications are recommended to address these challenges. However, every effort should be made to use consistent, reproducible, efficient, and ergonomically sound positioning techniques to create the best examination and patient experience possible.

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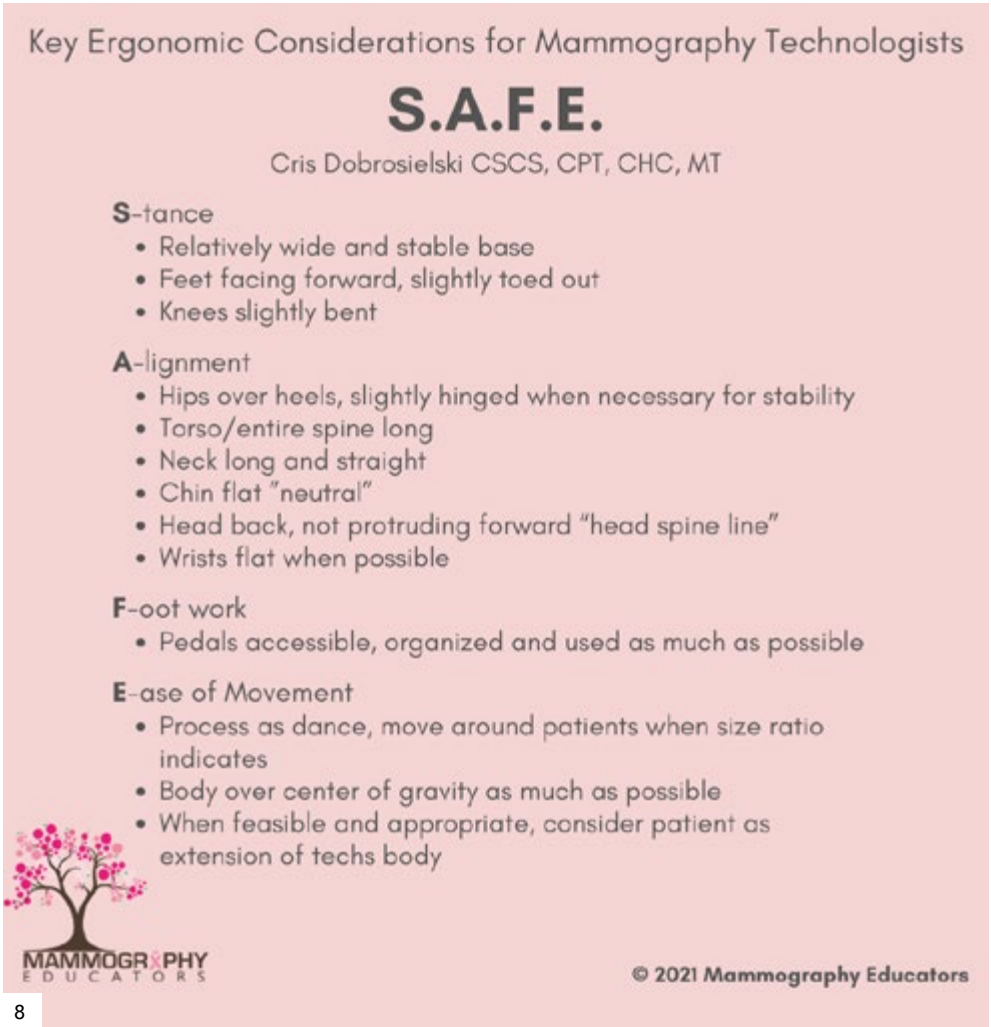

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Figure 8. Ergonomic recommendations for mammography technologists. Published with permission.

Radiology Advocacy: Why and How to Get Involved

By Amy K. Patel, MD

Amy K. Patel, MD

In an increasingly competitive health care environment, radiology advocacy is imperative, arguably now more than ever.

Key to radiology advocacy is to get involved early. The earlier you engage in advocacy endeavors, the sooner you become aware that it is as crucially important as your day-to-day clinical work. Also, the sooner you get involved, the sooner advocacy becomes a habit and a state of mind. Although I started getting involved in advocacy endeavors as a resident, do not despair; one can start at any career level. We need "radvocates" (radiology political advocates) at all career levels and practice types. Luckily, there are a myriad of opportunities to get involved at the local, state, and national levels.

At the local level, efforts such as becoming involved in breast cancer advocacy groups and organizations like the American Cancer Society can be great ways to have a voice in your community. Community outreach efforts such as speaking at various events/venues and to the media are other fantastic ways to increase awareness of issues like the importance of annual breast cancer screening. Hosting site visits at your place of work can be an effective way to show local elected officials what we do as breast radiologists, which can be incredibly crucial when attempting to enact policy changes.

At the state level, efforts such as becoming involved in your state radiological society can be extremely effective to ensure that you are informed on the issues that we continue to face in radiology and that you have a stalwart network you can turn to when needing assistance to enact policy, organize an advocacy event, and more.

At the national level, efforts such as joining the ACR and being part of the ACR Radiology Advocacy Network and the political action committee RADPAC are crucial for consistent advocacy involvement.[1] Of course, being a member of the SBI is also imperative, and serving on the Communications and Advocacy Task Force can be another way to get involved in this type of work.[2]

As exhausting as our clinical days may be, exacerbated by an ongoing pandemic coupled with the challenges of work-life integration, I encourage you to find it within yourselves to go beyond that and contribute to advocacy endeavors in some way, whether at the local, state, or national level. As Dr. Zeke Silva, former chair of the ACR Commission on Economics, says, "Make advocacy automatic."[3] Our patients and the future of our profession depend on it.

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LATE CAREER AND RETIREMENT COLUMN

The SBI recognizes that there are many stages in its members' careers. To complement the current Member-in-Training and Young Physician Section columns, *SBI News* is introducing the Late Career and Retirement Column, which we hope will be of interest and benefit to breast radiologists in the latter part of their careers, at and beyond retirement. If you are in the latter part of your breast radiology career, are transitioning into retirement, or are retired, we welcome your thoughts for future articles in this column. Please send any comments to info@sbi-online.org.

Mary Scott Soo, MD

Retirement From a Breast Imaging Career:
Radiologists' Reflections

By Mary Scott Soo, MD

As an introduction to this topic, *SBI News* submitted a survey to SBI members over 40 years of age regarding their late-career experiences and reflections. We received numerous excellent responses from radiologists who reported being either (1) in the last third of their career, (2) envisioning or planning retirement in the next one to three years, (3) currently transitioning into retirement (from one year before to one year after retirement), (4) retired for one to five years, or (5) retired for more than five years. This first article focuses on the respondents who were either envisioning or planning retirement in one to three years or were currently transitioning into retirement. Factors leading to retirement, associated challenges, reasons to be excited in this phase of their life, and advice for earlier-career faculty are discussed.

In response to our survey, over half of the breast radiologists who were transitioning into, planning, or envisioning retirement indicated a combination of factors leading to their decision to retire. "Opportunity to pursue other interests" and "work became too busy or stressful" were the most common reasons. Practice challenges related to corporate take-overs, difficulty with administrators, information technology stressors, and the COVID-19 pandemic were some specific recurring themes related to work stress. Those currently still working described the newfound freedom of working merely because they enjoy their patients and clinical practice. Some shifted to part-time or teleradiology work, happy to better control their own schedules and no longer feeling weighed down by administrative duties, productivity metrics, and long hours covering multiple clinics. Financial security was the third most common factor influencing retirement, and several respondents indicated that health-related concerns prompted their decision.

When asked what excited them most about this stage of their career, most respondents anticipated focusing on areas of interest outside work, spending more time with family, traveling, and pursuing hobbies that had been sidelined because of lack of time and energy. Several described wanting to engage more in their local communities, and some wanted to remain involved in medical societies, community education, and part-time work: "...working because I enjoy it" or "to keep my mind active."

Contemplating retirement was not without its challenges, however. When asked what they considered the most challenging factors in the retirement process, approximately half of this group planning or transitioning into retirement mentioned a combination of factors. The most common concerns were losing their identity as a radiologist, missing clinical practice, and missing colleagues, staff members, and friends. Several indicated that navigating retirement issues (eg, insurance, Medicare, and Social Security) was difficult, and other individuals described financial concerns, health and disability issues, lack of mental engagement, not enough additional interests, and boredom.

What advice do radiologists contemplating or transitioning into retirement have for early- and mid-career breast radiologists? The survey results strongly emphasized self-care: finding a radiology practice that is a good fit based on your core values, optimizing work-life balance, and embracing clinical practice and patient care. Respondents emphasized working in a practice you enjoy and, conversely, not staying in a practice setting that you do not find professionally fulfilling and enjoyable. Specific comments from several radiologists included "Understand the work politics and avoid them; life is too short for toxic people or toxic jobs," "Don't succumb to the radiology assembly line mentality in exchange for money," and "Change may be hard, but being unhappy is worse." One final comment emphasized, "Make sure you're in a practice that values you and your contributions in order to feel valued and avoid burnout."

Almost two-thirds of the responses addressed self-care through work-life balance. While one respondent commented that this is easier said than done, numerous suggestions for maintaining work-life balance emphasized balancing work and time off early on. Several radiologists confirmed that working part-time helped balance the demands of home and work, and others recommended hiring enough people to minimize stress. From a financial standpoint, numerous respondents recommended planning early for retirement. One radiologist emphasized finding the balance between preloading your retirement portfolio and carving out a less than full-time position

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RADIOLOGICAL SOCIETY OF NORTH AMERICA 2021 ANNUAL MEETING

By Nidhi Sharma, MD

Nidhi Sharma, MD

The 107th Scientific Assembly and Annual Meeting of the Radiological Society of North America (RSNA) transpired in a well-executed fashion as an in-person and virtual meeting from November 28 to December 2, 2021, at McCormick Place in Chicago. Hundreds of outstanding presentations on groundbreaking research, including artificial intelligence (AI) and innovative technologies, and networking events highlighted this year's annual meeting, with the theme "Redefining Radiology."

The meeting was inaugurated on Sunday with an opening plenary session by RSNA President Dr. Mary Mahoney, FACR, FSBI, Benjamin Felson endowed chair and professor of radiology at the University of Cincinnati College of Medicine. She addressed the meeting with "Redefining Radiology: The Road Ahead," emphasizing the vision of a collaborative, equitable radiology world using the tenets of quality-based and patient-focused care, creating unique paths forward with collaboration, civility, inclusiveness, and diversity at our core.

This was followed by a highly impactful opening plenary lecture by Dr. James Merlino titled "How to Deliver Safe, High-Quality, Patient-Centric Care." He highlighted the role of empathetic, patient-centric, personalized, respectful, consistent, communication-based care.

The RSNA dedicated the scientific assembly program to the memory of Sanjiv S. Gambhir, MD, PhD, and Lawrence W. Bassett, MD, FACR, FSBI, both compassionate educators and esteemed pioneers who dedicated their careers to advancing radiology. This year's outstanding educator was awarded to Dr. Adam E. Flanders, prolific mentor, author, and pioneer for digital learning, professor of radiology and vice chair of enterprise imaging informatics at Thomas Jefferson University in Philadelphia. Outstanding researcher was awarded to Dr. Pamela K. Woodard, one of the foremost authorities in cardiothoracic imaging research and translating novel cardiovascular positron emission tomography (PET) radiotracers, who is professor of radiology at Mallinckrodt Institute of Radiology, Washington University, St. Louis.

The RSNA's highest honor, the Gold Medal award, was given to three renowned leaders who each have contributed significantly to the advancement of our field. Dr. Yoshimi Anzai, Dr. Richard L. Ehman, and Dr. Jonathan S. Lewin were the esteemed recipients of this honor at the 107th Scientific Assembly and Annual Meeting.

The 2021 RSNA meeting abounded with novel breast imaging presentations and refresher courses. The disparate topics of exhibits and scientific presentations in breast imaging were executed flawlessly and gave the audience opportunities to attend contemporaneous sessions on their own time if they chose virtual attendance. The assortment of topics included AI, radiomics, and newer applications of various breast imaging modalities.

A keynote breast imaging presentation by Philipp Dominik Stelzer, MD, focused on assessing the value of abbreviated breast magnetic resonance imaging (MRI) in real-world scenarios. The study identified table-switching time between patients as an important part of a viable strategy to increase capacity and cost efficacy. Dana Ataya, MD, discussed the results of a study showing that radiomic features on dynamic contrast-enhanced computed tomography are helpful in stratifying ductal carcinoma in situ lesions, upgrading these lesions to invasive malignancy, and planning management.

Multiple sessions focused on the wider impact of AI systems in breast cancer screening and diagnosis. These talks covered the spectrum from performing critical evaluation of AI systems to understanding the implications of initial results of pioneering clinical AI studies and exploring opportunities and challenges when implementing AI in routine clinical practice. Linda Moy, MD, FSBI, from New York University, focused on the role of AI algorithm development for automated breast ultrasound examinations. She discussed that by using a high sensitivity threshold, AI-based software may function as a stand-alone interpreter and eliminate cases with a low probability of malignancy from the radiologist's work list. She additionally presented study results that revealed how AI decision support improves the diagnostic accuracy of breast ultrasound for detecting additional cancers and decreasing unnecessary biopsies.

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Retirement From a Breast Imaging Career: Radiologists' Reflections (continued from page 14)

to begin pursuing personal interests before retirement, thus lessening the burnout factor. Another stated, "Live within your means and become financially secure as early as possible. This allows you to make choices that really meet your needs. Trapped in a difficult practice? Change to another. Need flexible time for your family? Take it." Most radiologists urged spending time with family and cultivating meaningful outside interests and hobbies long before retirement so you can look forward to exploring these when you do retire. One even had this specific advice: "Develop a hobby aside from golf or tennis, as you may not be able (when you retire) to do the sports that you have done previously."

In terms of embracing clinical breast imaging practice and patient care, our survey respondents repeatedly emphasized ideas of being an expert, a subspecialist, "the best in your field." One added, "Don't take any call." Another specific recommendation was to "become the best possible 'screener' that you can." One respondent found that "staying up to date in your knowledge base and collaborating with supportive colleagues will give you confidence and reduce stress in your daily practice. The best way to stay up to date is to attend SBI symposium yearly, which I did."

Other comments encouraged maintaining state-of-the-art imaging and frequent engagement and cooperative efforts with breast medical, surgical, and radiation oncologists and pathologists. Further, they urged early-career radiologists to be available and contribute. "Be visible to your patients and volunteer in your community with your time and financial gifts." They recommended getting involved with peer radiologists, hospital staff and administrators, medical staff and partnership affairs, and medical societies, "...but focus on one and don't overdo it."

Last, but certainly not least—perhaps the most important of all—was this specific recommendation: "First and foremost, take care of the patient and provide assistance to your referring physicians. Every study you interpret belongs to a patient, a human being. Treat it like you would want your study to be treated." Radiologists responding to the survey repeatedly remarked on the personal and professional value and appreciation of their breast imaging careers, with fulfilling and precious moments of direct patient care and support. One final comment to early-career faculty echoes what we all recognize about our breast imaging careers, even amidst our busy work days: "Enjoy. It's a special opportunity."

Radiological Society of North America 2021 Annual Meeting (continued from page 15)

Tuesday morning sessions highlighted the role of mammographic breast density and its impact on risk categorization. Stamatia Destounis, MD, FACR, FSBI, presented the results of a study that showed that younger premenopausal women in low to intermediate risk categories were more affected by the addition of mammographic density to the risk assessment model, given dense breasts, and that they may still benefit from supplemental imaging. Ioannis Sechopoulos, PhD, presented an interesting study showing that if the breast thickness is also considered, the same criteria for categorizing volumetric breast density can be used worldwide for applications such as radiation dose estimates or risk modeling.

Sessions on PET-MRI were highly informative. Fibroblast activation protein (FAP)–directed PET-MRI and consecutive whole-body scanning with gallium Ga 68 FAPi-46 is a promising modality to assess local tumor extent and detect lymph node and distant metastases. 18F-fluoroethylcholine PET-MRI is an additional new modality to diagnose lymph node metastases in patients with newly diagnosed breast cancer.

Multiple enriching presentations on breast MRI were also a feature of this year's meeting and included a keynote talk by Savannah Corrina Partridge, PhD, on breast diffusion-weighted imaging. Dr. Hubert Bickel introduced the bADC category system as a simple tool to integrate apparent diffusion coefficient (ADC) into clinical breast MRI reporting, and Dr. Raoul Varga discussed the reproducibility and accuracy of ADC in breast MRI. Dr. Christopher Comstock, FACR, FSBI, elaborated on the role of and future directions for abbreviated breast MRI, including diffusion-weighted imaging, ultrafast protocols, computer-aided interpretation, noncontrast imaging, and low-cost scanners.

Even amidst an ongoing pandemic, RSNA left no stone unturned in making this scientific assembly a huge success. It was a welcome change to meet many radiologists in person after nearly two years of virtual meetings. There were numerous networking events, breakout sessions, vendor booths, Q & A chats during and after each presentation, and outstanding presentations at this exposition. Connecting with our friends, alumni, and the radiology community in person in the electrifying atmosphere of McCormick Place was a thoroughly gratifying and endowing experience. I look forward to attending next year apace with thousands of radiologists from our worldwide community. A chilly evening stroll across the iconic Navy Pier adds a finishing touch to the magnificent city views from the incredible rooftop observation deck at John Hancock Center. Ah, Chicago!

PHYSICS & TECHNOLOGY COLUMN

RSNA 2021: A Little Different but Lots of Good Medical Physics!

By Elizabeth A. Krupinski, PhD

Elizabeth A. Krupinski, PhD

Back live at the Radiological Society of North America (RSNA) meeting in Chicago! It was great to attend in person this year. The meeting had just under half the usual number of attendees, which was far more than I had anticipated considering the virtual option that helped fill out audiences. Even with half the crowd to weave through running from session to session, it was impossible to catch all of the exciting breast-related medical physics presentations. I was, however, able to observe quite a few exciting presentations and posters in the field.

My favorite presentation was a very practical one. These types of studies reveal so much about the critical importance of clinical medical physics and the key role it plays in daily patient care. Hannelore Verhoeven, MSc, presented "A Large Retrospective Study of Non-Compliance Findings at Half Yearly Medical Physics Tests of Digital Mammography Devices (DM) Using a Vendor Neutral (European) Test Protocol." The group surveyed 131 DM devices in a large network from eight major vendors over a four-year period using the acceptability criteria in European Union document RP162. Evaluations were performed on site on a half-yearly basis, resulting in 1752 reports. Of those, 472 had faults and 144 were graded as severe (indicating that if the issue was not resolved, a suspension of the device would be required). None, however, required detector replacement. The top five reasons for severe grades were alignment of the x-ray field, compression, automatic exposure control thickness compensation, low contrast detectability, and tube voltage error. The top fault overall was homogeneity. It was interesting to hear that most of the issues were found in the first 10% of the device's lifetime and then stayed rather constant thereafter. Compression, automatic exposure control, and liquid crystal display issues dominated in the early periods, and alignment issues were more prevalent later. There were no major differences between vendors on most issues. Overall, all issues studied were readily addressable.

On the technology development front, John Boone, PhD, talked about "A Stationary Breast Tomosynthesis System Using a Two-Dimensional Multiple X-Ray Source Array with Thermionic Cathodes." The problem addressed with such a device is the fact that current breast tomosynthesis systems travel through an arc over the patient to acquire images that can cause motion blurring. This can be exacerbated by the fact that the scans are 4 to 25 seconds, providing ample time for patient motion. A stationary system alleviates both problems, addressing blurring from arc motion and reducing patient motion with the decreased scan time. The system was based on an 11 x-ray source array (MXA) situated 70 cm above a flat-panel detector that has 0.127-mm detector acquisition frames. The two-dimensional array has 33 source locations. A prototype was developed, and early phantom studies indicated an average improvement of a factor of 2.85 in signal difference to noise ratio. Thus, although it is still in the very early stages, this type of MXA-based system may improve breast tomosynthesis image quality with more symmetric and thinner slice sensitivities.

An interesting psychophysics and observer performance study was presented in a poster by Yen Zhi Tang, MD, and colleagues, who assessed "The Impact of Slice Thickness on the Interpretation of Digital Breast Tomosynthesis." They presented 125 benign and 25 malignant digital breast tomosynthesis cases to two readers in the standard format (1-mm slices with no overlap) and in an experimental protocol (10-mm slabs with a 5-mm overlap). Readers reported findings as BI-RADS 0, 1, or 2. Intraobserver agreement (standard protocol, 96%; experimental protocol, 97%) and interobserver agreement (standard protocol, 91%; experimental protocol, 91%) were both high. Sensitivity was 97% for both readers in both conditions. For one reader, specificity was 79% for the standard protocol and 76% for the experimental protocol; for the other reader, specificity was 74% for both protocols. Based on these results (although with only 2 readers), it appears that thicker slabs have good potential for use in clinical interpretation.

Another study on digital breast tomosynthesis by Kai Yang, PhD, and colleagues was "Power Spectrum Analysis of Breast Parenchyma with Digital Breast Tomosynthesis Images in a Longitudinal Screening Cohort from Different Vendors." Their goal was to determine whether they could quantitatively demonstrate differences in image appearance of breast parenchyma as a function of vendor device (n = 2). The metric

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NEW FELLOWS

Manisha Bahl, MD, MPH, FSBI

Dr. Bahl is a radiologist at Massachusetts General Hospital and Harvard Medical School and is a past director of the Massachusetts General Hospital breast imaging fellowship program. She is a graduate of Stanford University; the University of California, San Francisco, School of Medicine; and the Harvard School of Public Health. She completed residency and fellowship training at Duke University Medical Center and most recently completed the Professional Certificate in Machine Learning and Artificial Intelligence at the Massachusetts Institute of Technology.

Dr. Bahl is a National Institutes of Health–funded investigator whose research interests include the application of artificial intelligence to improve outcomes in women with breast cancer and the clinical assessment of digital breast tomosynthesis. She has won numerous awards for her research, including the American Roentgen Ray Society President's Award, has served on study sections for the National Institutes of Health and Department of Defense, is an associate editor for the *Journal of Breast Imaging* and for *Radiology: Artificial Intelligence*, and is a podcast cohost for the journal *Radiology*.

Dr. Bahl has lectured widely at national and international conferences on various topics in breast imaging. She is a recipient of the Radiological Society of North America William W. Olmsted Editorial Fellowship, the ACR E. Stephen Amis, Jr., MD, Fellowship in Quality and Safety, the American Association for Women in Radiology Lucy Frank Squire Distinguished Resident Award in Diagnostic Radiology, the American Medical Association Foundation Leadership Award, the Stanford University President's Scholar Award, and the Massachusetts General Hospital Excellence in Resident Education Award.

Katerina Dodelzon, MD, FSBI

Dr. Katerina (Katia) Dodelzon is a fellowship-trained breast imager and an associate professor of radiology at Weill Cornell Medical College in the Division of Women's Imaging. She serves as the associate program director for the diagnostic radiology residency program and the breast imaging fellowship training program at Weill Cornell. Dr. Dodelzon's research interests include optimization of breast cancer screening across populations and gender/racial inequality within radiology. In addition, she is actively engaged in curriculum development and teaching techniques to better equip residents, fellows, and medical students for the evolving nature of the field of radiology. She is leading a department-wide initiative on patient-centered communication.

Eva C. Gombos, MD, FSBI

Dr. Gombos is a board-certified diagnostic radiologist in Boston, Massachusetts, affiliated with the Brigham and Women's Hospital (Mass General Brigham) and the Dana-Farber Cancer Institute. She was born and raised in Hungary and graduated cum laude in medicine from Semmelweis University in Budapest, Hungary, in 1986. She moved to Israel in 1989 and completed a residency in diagnostic radiology in 1995 at Kaplan Medical Center, Rehovot, a teaching hospital affiliated with Hadassah and the Hebrew University of Jerusalem Medical School. She subspecialized in breast imaging and served as an acting section head at the Division of Breast Imaging and Biopsy at Kaplan Medical Center from 1997 to 1998.

After moving to the United States in 1999, Dr. Gombos worked at Mount Sinai Medical Center in Miami Beach, Florida, as a breast imaging fellow in the section of breast imaging and as a breast pathology fellow. She also completed a residency in surgical pathology, graduating in 2004.

In 2004 she joined the breast imaging section of the Department of Radiology at Brigham and Women's Hospital, spending most of her time on clinical service. Since 2007, she has been the director of breast imaging research at Brigham and Women's Hospital.

In 2008 Dr. Gombos was awarded the Association of University Radiologists GE Radiology Research Academic Fellowship to study the use of breast magnetic resonance imaging for diagnosis and interrelation with other diagnostic specialties, particularly anatomic and molecular pathology. Her current major research focus is on testing intraprocedural imaging in breast-conserving surgery in the advanced multimodality image-guided operating suite. She has published 25 research and 27 other peer-reviewed articles as primary author or coauthor, has coauthored 2 textbooks on breast imaging, and has written numerous book chapters, educational materials, and meeting proceedings.

Sally Hayward Goudreau, MD, FACR, FSBI

Dr. Goudreau is a professor of radiology at UT Southwestern Medical Center and has served for 10 years as director of the breast imaging fellowship program. Her passion for both clinical breast imaging and research has been evident throughout her career. She earned her medical degree at UT Southwestern and completed her radiology residency and fellowship training at the University of Iowa Hospitals and Clinics. Before joining the UT Southwestern faculty in 2008, Dr. Goudreau was an assistant professor of radiology at the University of Cincinnati Barrett Breast Center and then the medical director of breast imaging and director of the women's imaging fellowship program at the University of Colorado Health Science Center in Denver. In 1997 she relocated from Denver to Dallas, where she served as the medical director of breast imaging at Southwest Diagnostic Imaging Center and the Women's Diagnostic and Breast Center at Presbyterian Hospital of Dallas.

Dr. Goudreau joined the SBI in 1995 and is currently an active member of the SBI Patient Care and Delivery Committee. She serves on numerous UT Southwestern and departmental committees and has a strong commitment to education, demonstrated by her work as a Medical Student and Resident Ambassador, service on the UT Southwestern Medical School Admissions Committee, and teaching as an invited guest lecturer around the country.

She and her husband, Jeff Goudreau, MD, FACP, have a passion for supporting higher education through medical volunteer work and endowed scholarships at Texas A&M University, Baylor University, and Notre Dame University, where their donations fund documentary filmmaking pertaining to breast cancer.

Tanya W. Moseley, MD, FSBI

Dr. Tanya Washington Moseley is a professor of breast imaging and breast surgical oncology at the University of Texas MD Anderson Cancer Center in Houston, Texas; a diversity, equity, and inclusion thought leader; and a 2022 Doctor of Business Administration in Healthcare Management and Leadership candidate. Dr. Moseley served as the medical director of the Julie and Ben Rogers Breast Imaging Center at MD Anderson from 2018 to August 2021. She is a past section chair of the American Roentgen Ray Society Case-Based Breast Imaging Review course. Currently she is a member of the ACR Breast Ultrasound Accreditation Committee and is the RadiologyInfo.org breast imaging content steward. In addition to her medical doctorate, Dr. Moseley is a project management professional, a physician breast patient navigator, and a manager of quality and organizational excellence. A distinguished educator, Dr. Moseley has lectured in six of the seven continents. Born in the great state of Mississippi, Dr. Moseley is a devoted wife, daughter, sister, friend, colleague, and mom of nine (two humans and seven cats).

Rifat A. Wahab, DO, FSBI

Dr. Wahab is an associate professor of radiology specializing in breast imaging. She obtained her medical degree from Michigan State University College of Osteopathic Medicine and completed her diagnostic radiology residency with the Michigan State University Consortium, where she served as a chief resident. She completed her fellowship in women's imaging at Vanderbilt University. Dr. Wahab has a strong interest in education, serving as the fellowship director for breast imaging and as founder of the Midwest Breast Imaging Fellowship Consortium. Her research has been presented at national conferences such as those of the American Roentgen Ray Society, the American Osteopathic College of Radiology, and the SBI. She has published book chapters and journal articles in women's imaging and is the social media editor for the *Journal of Breast Imaging*. Dr. Wahab serves on national committees regarding medical education through the SBI and other organizations.

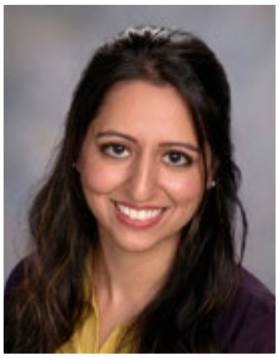
Physics & Technology Column: RSNA 2021: A Little Different but Lots of Good Medical Physics! *(continued from page 17)*

used was noise power spectrum, which is a common metric of image quality using the slope of a linear function between log-frequency and log-power as a measure of breast texture. Only normal cases (n = 25) were included, and analyses were done within the breast tissue region. Thirteen of the cases had scattered fibroglandular density and 12 were heterogeneously dense. They found significant differences in the presentation of breast anatomy between vendor devices and significant effects across breast density groups. They framed the significance of the results in terms of the importance of external validation when developing artificial intelligence and other techniques based on computer vision. It seems likely that, at the very least, human readers may need to be aware of these differences because of the potential impact on their perception of breast parenchyma characteristics.

Even with fewer people attending the RSNA meeting this year, it was impossible to view all of the posters and talks related to medical physics and breast imaging. The few presented here, however, demonstrate the wide variety of topics covered and the very real impact and implications these basic science studies can have on breast imaging technology and use.

Liquid Biopsy: Potential Applications in Breast Cancer Diagnosis, Prognosis, and Treatment

By Anam Salman, MD; Anita Mehta, MD



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We have come far from the days when patients with indeterminate imaging findings in the breast were sent to surgery for pathologic diagnosis. Image-guided percutaneous tissue biopsies are now the standard of care and provide a safe, well-tolerated, cost-effective approach to diagnosing breast lesions. Developments in the field of cellular biology and genomics have allowed further characterization of tissue samples into molecular subtypes, allowing for targeted therapy, part of a growing paradigm shift in cancer care termed *precision medicine*.[1] Percutaneous biopsies, however, have their limitations. It is well established that there is genetic heterogeneity within a tumor and therefore obtaining a few core samples from a mass may not provide a complete picture of tumor biology.[2] Moreover, cancers are dynamic and can evolve over time and in response to therapeutic pressure.[3] Metastatic sites may also have different genetic profiles than the primary tumor site.[2] A liquid biopsy is an exciting novel approach that has the potential to overcome some of these limitations. This technique involves the acquisition and analysis of tumor-derived material such as DNA, RNA, and intact tumor cells in body fluids, providing a more complete analysis of a tumor's genetic landscape. Liquid biopsy has potential clinical applications in cancer screening, prognosis, and monitoring treatment response.

Components of a Liquid Biopsy

As cancer tissue forms and grows, various components are released into the bloodstream. These components, termed the *tumor circulome*, include circulating tumor DNA (ctDNA), circulating tumor RNA, circulating tumor cells (CTCs), extracellular vesicles, and tumor-educated platelets.[4] Fragments of free-floating DNA in the bloodstream are not a new discovery. Cell-free DNA (cfDNA) was first identified in the bloodstream in 1948 and is normally present in healthy individuals. Levels are amplified during trauma, myocardial infarction, and autoimmune processes.[3] However, ctDNA, a subset of cfDNA, should be present only in patients with underlying cancer tissue, giving rise to its potential use as a biomarker.[3]

Intact CTCs are cells that actively or passively detach from the primary tumor site and enter the bloodstream.[4] The presence of CTCs in the bloodstream has been shown to be an important factor in the development of metastases, and the number of CTCs can be used as a prognostic indicator.[3] In addition to quantitative measurements, genomic analysis of CTCs is based on polymerase chain reaction tests, next-generation sequencing, and fluorescence in situ hybridization.[4] Currently, the most common test used for CTC detection in clinical trials is the CellSearch system (Menarini Silicon Biosystems, Inc), which has been approved by the US Food and Drug Administration for metastatic breast, colon, and prostate cancer.[5]

Additional useful components of a liquid biopsy are extracellular vesicles, which are membrane-bound vesicles containing pieces of RNA, DNA, and proteins that serve as fingerprints for tumor origin. Advantages of analyzing extracellular vesicles include their abundant quantities in blood and their stability at the time of acquisition secondary to a protective lipid membrane.[4] It is clear that platelets also play a significant role in cancer function and growth.[4] Tumor-educated platelets incorporate tumor RNA, altering their mRNA profile.[4] Tumor-educated platelets therefore differ from platelets of healthy individuals, making them a useful biomarker.

Clinical Applications in Breast Cancer

Screening

Many researchers are investigating the potential of liquid biopsies for detecting early breast cancer in asymptomatic women. Studies have shown that high levels of cfDNA are associated with cancer, so specific cfDNA genes may be able to identify a patient with presymptomatic disease.[3] For example, Agostini et al determined that levels of cfDNA ALU247 were significantly higher in breast cancer patients and can be used to differentiate patients with cancer from those without cancer.[6]

Spontaneous somatic mutations known to cause cancer can occur and circulate in the bloodstream but never lead to the development of cancer. Liquid biopsies can therefore result in overdiagnosis in patients with preclinical disease. A group of researchers recently created CancerSEEK (Exact Sciences Thrive LLC) to address this issue.[7] This diagnostic test is a liquid biopsy that uses combined assays of genetic mutations and protein markers to decrease false positives in early detection and improve accuracy in localizing tumor origin.[4,7]

Predicting Recurrence and Longitudinal Prognosis

Liquid biopsies are less invasive than tissue biopsies, making repeated sampling more feasible. Analysis of the tumor cell population in the bloodstream at multiple stages of therapy has the potential to predict prognosis and identify early recurrence. Researchers have found that patients with CTCs in their blood are twice as likely to die of breast cancer as those who do not have CTCs at the time of diagnosis.[5,8] The presence of CTCs also correlated with shorter overall survival, disease-free survival, and distant disease-free survival.[5,8] In an ECOG-ACRIN trial that studied the significance of CTC testing five years after a diagnosis of hormone receptor–positive disease, the annual risk of recurrence was 21.4% in women in whom at least one CTC was detected, as compared with only 2% in women with no CTCs detected.[5]

Although less extensive data on circulating DNA are available at this time, smaller studies have shown significant potential for the use of cfDNA and ctDNA as prognostic indicators.[5] Magbanua et al examined the presence of ctDNA in patients with early breast cancer undergoing neoadjuvant chemotherapy.[9] They found that the lack of ctDNA clearance from the blood after neoadjuvant chemotherapy predicted poor response and metastatic recurrence.[9] This study also found that clearance of ctDNA correlated with improved survival even in patients who did not achieve pathologic complete response.[9]

Targeted Treatment

The genetic information from a liquid biopsy reflects the current tumor population and can be used to determine the most effective targeted therapy. For example, primary breast cancers usually have no mutations in the *ESR1* gene, which encodes for an estrogen receptor, whereas metastatic breast cancers have high rates of mutations.[3] These mutations are thought to arise from therapeutic pressure following endocrine therapy.[3]

In a review of patients with estrogen receptor–positive metastatic breast cancer who were receiving endocrine therapy, *ESR1* mutations in ctDNA were more prevalent in those whose cancer progressed under any line of endocrine therapy, strongly suggesting that *ESR1* mutations play a role in endocrine therapy resistance in metastatic breast cancer.[3,10] Additionally, *ESR1* mutations in ctDNA can be detected approximately 6 to 7 months before clinical progression, providing an opportunity for early therapeutic intervention and a change in targeted treatment as needed.[3,11]

Limitations

Liquid biopsies in breast cancer have yielded promising results thus far, but many limitations need to be addressed before this technique can be routinely used in the clinical setting. Technologies for isolating and analyzing tumor-derived genetic material from the blood have undergone rapid development, but the sensitivity and specificity of these techniques are relatively low. Furthermore, cfDNA, ctDNA, and CTC levels and integrity can reliably differentiate patients with advanced/metastatic breast cancer from healthy individuals, but their ability to identify patients with early-stage disease or in situ carcinoma remains uncertain.[3] How to manage patients who have detectable ctDNA before any clinical or radiological abnormalities develop is also uncertain.[3]

Conclusion

Currently, liquid biopsies may be used as a supplementary tool that complements and builds on results from conventional tissue biopsies. In the future, liquid biopsies may play a significant role in breast cancer management, with potential applications in early diagnosis and therapeutic intervention.

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Huria Patwardhan

By Hannah Perry, MD

Hannah Perry, MD

H. Perry: Please tell me about yourself and your background.

H. Patwardhan: When I was diagnosed with breast cancer in 2016, I was 36 years old and living a relatively healthy lifestyle. I was born and raised in a suburb just south of Pittsburgh, Pennsylvania, to Pakistani immigrant parents. I had a fairly uneventful childhood and young adulthood, healthwise. Looking back on it, I may have suffered from a weakened immune system, as I was often afflicted with unusual infections, both viral and bacterial, such as cellulitis infections, malaria, and frequent skin abscesses.

After I graduated from college, my first job was as a paralegal in a building that was just two blocks from the World Trade Center in New York. It was the second Tuesday of my first real job when the buildings were attacked. I continued to work in lower Manhattan for the next 11 months, and the air was tinged with the smell of burning debris.

Following this traumatic experience, I moved to Atlanta for three years to attend law school. The next few years were joyful and hectic as I moved back to Manhattan for a short period and then to Los Angeles. I became pregnant and had two complication-free pregnancies resulting in two healthy and happy daughters, who are now aged 9 and 7 years. I remember feeling blessed, lucky, and perhaps a bit undeserving of such a beautiful life. Candidly, I felt like life was almost too good. Maybe this was the way I was raised, to be suspicious of the blessings in front of me and to fear the "evil eye" so ubiquitous in my culture. That all changed in May 2016.

How you were diagnosed with breast cancer?

In May 2016, I noticed a lump in my right armpit. It felt more like a boil or an infected hair follicle than anything of concern. I mentioned it to my husband in passing without thinking much of it. On Mother's Day of that year, my husband mentioned our discussion to my mother-in-law, who is a physician. My mother-in-law made me promise that I would have it checked immediately.

At an appointment with my gynecologist, I pointed out that I felt a lump. The doctor was able to feel the lump in my armpit but was unable to palpate anything in my breast. She concluded that this finding was likely a cyst. The doctor ordered an ultrasound but said that I could wait a couple of months to see if the cyst resolved on its own. When I discussed this recommendation with my mother-in-law, she advised me to get the ultrasound right away.

Two weeks later, I arrived at my ultrasound appointment alone, not feeling like I needed any family support. The technologist began the appointment with conversation about herself and her family, sparked by my interest in the homemade artwork adorning the ultrasound room. She asked about my children and their interests but then very quickly stopped speaking to me. You could almost immediately feel the tension build in the room, but I was still a bit oblivious to what was happening. I had been going on about my children when I realized that the technologist was adding lubricant to the ultrasound wand and moving it over my right breast and then my left breast and left axilla without saying a word. The technologist advised me that the radiologist would need to speak with me. The radiologist came in and told me that I would need to come back and have three biopsies, two of masses in my right breast and one of an enlarged lymph node in my right axilla. I would also need a mammogram. The doctor did not provide much more information other than to tell me that this was a suspected malignancy but that we would not know until we received the biopsy results. I had no idea at that point about a BI-RADS scoring system. My biopsies and mammogram were scheduled for five days later. These were going to be the longest five days of my life.

Then I was free to go. Was I meant to leave the exam room right away and go to my car? Why was it suddenly so hard to breathe? Will I be able to make it to my car? I was most certainly having a panic attack after being told that I might have cancer, but there was no one around to help me or tell me that it was okay to have these feelings. I must have looked visibly upset, but no one seemed to notice as I stumbled down the hall in search of a place where I could have a breakdown. Where was the "break down and cry" room with a medical professional to give you a nice big therapeutic hug? It did not exist. Where was that nice technologist that was telling me about her family? I couldn't find her. So I found an empty stall in the bathroom and had a good stifled cry and then went back to my car and drove (probably unsafely) home in rush-hour traffic.

I essentially learned of the news on my own the next day. On the recommendation of my dearest friend, who is a breast imaging radiologist, I requested the report of my ultrasound and was told that it would be emailed to me once it was complete. I was in a grocery store parking lot by myself when I received the email. No one called me to prepare me for what I was about to read in this report. There wasn't even a note of warning in the email with the attached report. I read the report and immediately Googled the terms and learned that a BI-RADS 5 score was "highly suggestive of malignancy estimated to be greater than or equal to 95%." I was in the car by myself in a parking lot when I found out I had breast cancer. It was like a punch in the gut.

How did you feel when you learned of the news?

I felt absolutely and totally shocked. This was not something that I had ever contemplated since I had no family history of cancer. I also felt like my body had betrayed me. I had just experienced the miracle of growing two humans inside my body, and it made me feel strong and almost invincible. How could this rotten cancer be growing and spreading inside my body without my knowledge? Was it already growing when I had my babies inside of me or when I was nursing them? How could my body do this to me?

Additionally, I felt mournful, like I was grieving the loss of my old cancer-free life. I soon came to learn that my odds of eradicating the cancer from my body were fairly high, but my mind would never be able to rid itself of the ceaseless anxiety of recurrence. I was forever going to be waiting for the other shoe to drop. I missed my prior life when the metaphorical shoe did not even exist.

I also had an overwhelming desire to determine how this happened. Did I do something wrong? Was there someone to blame? Was I exposed to something that caused this? How can I be sure that my daughters have not inherited some cancer-causing gene? After genetic testing led me to rule out a known genetic mutation that could have caused my cancer, my research led me to believe that my exposure to the toxic air in lower Manhattan for the months following the World Trade Center attacks may have triggered the growth of this cancer. Nonetheless, it has taken a few years and many teary conversations and therapy sessions to embrace the fact that I will never know with 100% certainty what caused me to develop this cancer. This is one of the hardest things for me to accept.

What was your treatment process? Did you face any treatment obstacles? How did you overcome them?

My treatment began with six rounds of neoadjuvant chemotherapy, which included two traditional chemotherapy agents and two targeted monoclonal antibody drugs. I would continue with one of the drugs, trastuzumab, for an additional 11 rounds of therapy. Next, I had bilateral mastectomies and placement of tissue expanders for reconstruction. Several weeks after the surgery, I underwent 33 rounds of radiation therapy and three sessions of radiation booster.

Throughout the active treatment process, I thankfully faced very few obstacles outside of the known side effects of the listed treatments. Aside from an allergic skin reaction to one of the chemotherapy agents early on in the infusion process and difficulty swallowing from radiation therapy, most side effects were expected.

My obstacles began after my active treatment period had ended and were mostly in connection with breast reconstruction. I suffered from recurrent cellulitis infections of the irradiated breast over the course of several years, requiring weeks of intravenous antibiotic treatments and additional breast reconstruction surgeries. I ultimately reached a point where I developed septic arthritis of my right shoulder and bacteremia likely stemming from recurrent breast cellulitis. I realized that implant-based reconstruction was not working for my body. Most recently, I had the implants removed and underwent another breast reconstruction surgery using only autologous tissue.

What motivated you during your diagnosis and treatment process?

My children and my family were my number one motivation throughout my treatment. I knew I had to do my best to rid my body of the cancer and heal from the treatments for them. On days when I was most acutely suffering from the side effects of chemotherapy or the pain and fatigue from surgery or radiation, I would obsess over all the things that I was not able to do for my kids and my husband. It was this feeling of helplessness on the bad days that motivated me on days when I felt better to get out of bed, move my body, do things for my kids, and be productive and useful.

While I was going through active treatment, my brain did me a huge favor by taking my emotions off-line for the most part. Despite feeling a bit numb during this time, I greatly benefited from rarely contemplating the worst-case scenarios. I always assumed that the treatments would be successful. On the rare occasion that I let my thoughts go to a dark place, which happened most during the last couple of rounds of chemotherapy, it was the thought of not being alive for my two little girls that motivated to me get into the car for that sixth round of chemotherapy.

What did you learn from your experience?

I find, even five and a half years later, that I am still learning from this experience and discovering new feelings. Oftentimes, my new feelings or revelations are diametrically opposed to conclusions I reached earlier. Obviously, I am continuing to process it all. What I struggle with most is the idea that a battle with cancer should be hugely transformative in an outwardly obvious way, but

I don't feel like it has been for me. I have changed and, hopefully, improved. However, I have grown in more subtle ways. Sometimes I feel inadequate, like I should be doing more with this experience. Other times, I feel confident that the life that I am living and the love and support that I am able to provide for my family and friends simply because I am here is a triumph in itself.

I have also learned that I am tough. I had suspected this about myself but had doubts that it was actually true. Now I know if I was able to get through six rounds of chemotherapy, lose all my hair, have a part of my body amputated, and then go through five more surgeries after that, I am tough. Nothing seems that hard anymore.

How has this diagnosis impacted your life?

The most important way this diagnosis has impacted my life is that it has compelled me to focus on my mental and emotional health, something that I should have been focusing on well before my diagnosis. Giving priority to my mental health has improved almost all of my interpersonal relationships and my relationship with my physical body. I am 100% more present and patient with my children and husband. I am a more empathetic and thoughtful friend and family member. I listen better both to others and to the signals that my own body is giving me. I still struggle with this on occasion, but I am more willing to slow things down when my children need me to or when my body requires it. Years ago, a good friend of mine used to have a Winnie-the-Pooh quote at the end of his emails that only now resonates so deeply with me: "Rivers know this: there is no hurry. We shall get there some day."

Are there any lessons that you think the breast imaging community can learn from your experience?

Please build a "break down and cry" room for your patients in your facilities! I realize this is not the case for all patients, but there are some, like me, who have such an obvious and clear-cut cancer diagnosis that a patient must deal with the realization that she has cancer well before she has found a breast surgeon or oncologist or even a therapist. In such situations, the breast imaging community and the people who treat patients at breast imaging centers need to be better equipped to support patients through this incredibly difficult time of uncertainty.

What advice would you give to other patients who are going through the diagnosis and treatment process for breast cancer?

My best advice would be to research, research, research, and take your time making decisions. I made too many decisions from a place of fear and panic and I felt rushed. My husband and I believed we were being thoughtful about decisions because we got second and third opinions from excellent physicians and surgeons, but we did not give ourselves the perspective that a little time can give. I would also advise to consult professionals or trusted friends and loved ones who are not medical professionals that treat cancer patients. Sometimes outside perspectives can help you think about the rest of your life, when cancer no longer has its hands on the wheel.

This brings me to my second piece of advice, which is to make decisions about your cancer treatment while considering the quality of your life going forward. It is so difficult to even think about the future when you are battling one crisis after another with a cancer diagnosis. But it is important to consider that most early-stage cancer is treatable and never returns. You will likely have years left to live, and you most definitely do not want to be held back by that cancer that bullied you years ago.

Huria Patwardhan

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