The Next Paradigm Shift

Embracing Hologic's 3DQuorum® Imaging Technology as a Breakthrough in Early Breast Cancer Detection

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Introduction

> ***"Do the best you can until you know better. Then when you know better, do better"*** – Maya Angelou

Change can be a difficult exercise for radiologists. We become accustomed to the nuanced aspects of our work environment – be it our hanging protocols, dictation macros, hot keys, or our precisely measured and preprogrammed seat and workstation heights. These carefully tailored interactions with our workspace offer a measure of stability, dependability, infallibility, and practice efficiency. Naturally, any perturbation of this delicate symbiosis between man and machine is usually accompanied by discomfort, hesitation, and reservation. There often is a reluctance to move away from systems that we are familiar with and have come to rely upon.

Change, however, is necessary in the practice of radiology as the field remains at the cutting edge of technological advancements, which in my opinion change our field for the better.

Mammography is the bedrock of breast cancer screening. The accuracy with which mammograms detect breast cancer hinges largely on image resolution. In my experience, the more details depicted on a mammogram, the more accurate the interpretation, which translates to earlier detection of breast cancer and ultimately to more lives saved. Today, digital breast tomosynthesis (DBT) is the state-of-the-art in mammographic imaging of the breast. Hologic 3Dimensions™ systems with Hologic Clarity HD® technology provide the highest resolution 3D™ images in the industry (70-micron pixel resolution).

However, high resolution, image-rich data introduces two noteworthy challenges:

1. Increased data storage requirements can place a strain on computer and network infrastructure.
2. More data takes longer to interpret and can cause radiologist fatigue and eye strain.

Fewer Images with Higher Resolution

To combat these issues, Hologic used Genius AI™-powered artificial intelligence (AI) technology within its mammography platform to develop 3DQuorum® SmartSlices, which resulted in a more efficacious product.

3DQuorum technology generates 6mm SmartSlices, an advanced reconstruction of the 3D™ dataset, which highlight relevant features on the mammogram. SmartSlices reduce the number of images to review, which saves radiologists as much as one hour in an eight-hour day of interpretation.[1,2] The result of these technologies is a better mammogram due to higher resolution, less radiation exposure and shorter interpretation/turnaround times.

Overcoming A Reluctance to Change

At the beginning of 2021, my company, RadNet, a leading provider of outpatient imaging with 353 locations and more than 500 radiologists across the country, underwent an enterprise-wide transition to Hologic 3Dimensions systems. I am stationed at BreastLink Medical Group outside of Los Angeles, one of RadNet's high-volume diagnostic breast imaging centers. We have five dedicated mammography rooms performing more than 25,000 procedures annually. As I witnessed our transition from another vendor's 3-year-old mammography units to the new Hologic 3Dimensions systems, I had an opportunity to combat the inertia I had developed in a well-entrenched practice environment. Having become accustomed to what I thought was state-of-the-art technology, it was difficult to reconcile that we were undergoing yet another 'upgrade'. My colleagues and I met this transition with a healthy dose of skepticism.

This reluctance to change was most salient as it concerned the adoption of artificial intelligence in the construction of the tomosynthesis dataset presented on our PACS as 6mm SmartSlices. Although this process is instantaneous and occurs in the post-image processing steps prior to the images arriving on our PACS, it required a leap of faith that there was no loss of any imaging information.

Readers' practice habits and search patterns vary when it comes to interpreting breast tomosynthesis. With our previous non-Hologic system, some of my colleagues preferred to thicken the volumetric dataset into so-called "slabs" measuring up to 10mm in thickness. We found this has some noteworthy advantages, including, but not limited to reduction in interpretation time and improved assessment of grouped calcifications. While no imaging information is necessarily lost in utilizing this method, theoretically a finding smaller than the thickness of a slab may be obscured by superimposed tissue within the slab.

Some readers, on the other hand, prefer to scroll through the thin planar sections of the volumetric dataset (1mm slice thickness) slice-by-slice. This method has one distinct advantage, which is peace of mind that the anatomy has been evaluated in its granular detail. It also has some noteworthy disadvantages, including longer interpretation times and increased noise. Regardless of the reader's preferred method of digital breast tomosynthesis interpretation, the notion that a computer algorithm would process, or in our eyes manipulate, the raw dataset prior to its presentation on PACS naturally gave us pause.

Fewer Images, Reduced Interpretation Time, and Greater Accuracy

The process of creating the 3DQuorum 6mm SmartSlice is illustrated in Figure 1. The entire stack of 1mm tomo slices is first evaluated for the presence of structures that may represent potential pathologies, such as calcifications, spiculations and distortions and rounded dense masses. A set of six adjacent 1mm slices are selected, and then combined into one 6mm SmartSlice. During this amalgamation process, any previously identified suspicious structures in these six slices are given high weight, ensuring their visibility is enhanced. This use of AI increases the clarity of these structures beyond their appearance that would result from a simple summing or slabbing of the data from the six component slices.

The next SmartSlice in the sequence uses six more 1mm slices, with a three slice overlap from the previous SmartSlice. The 3mm overlap ensures continuity, eliminates missed data, and makes scrolling through the SmartSlices smoother as there is a gradual transition from one SmartSlice to the next. As a result, the interpreting physician needs to evaluate a reduced number of slices, compared to 1mm slices leading to reduced interpretation time. Additionally, file sizes are smaller for network transmission.*

Our adjustment to this new technology was quite rapid and now we use it daily. Regardless of each reader's preferred method of interpreting DBT, planar versus slab, the resultant image quality was well received (Figure 2).

Improved Synthesized Images

One of the most striking features we noted when first interpreting the new images from the Hologic system is the

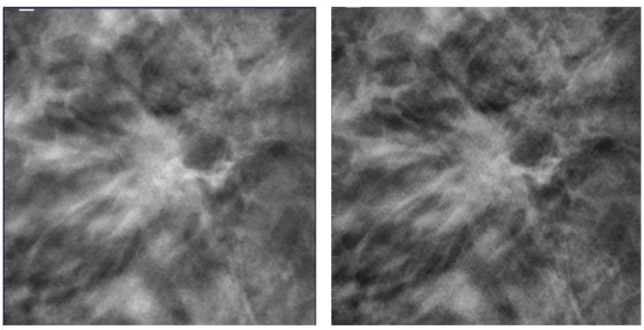


Figure 2. *The image on the left shows the appearance of a mass in a 1mm tomosynthesis slice and the image on the right shows the resultant 6mm SmartSlice that includes the mass.*

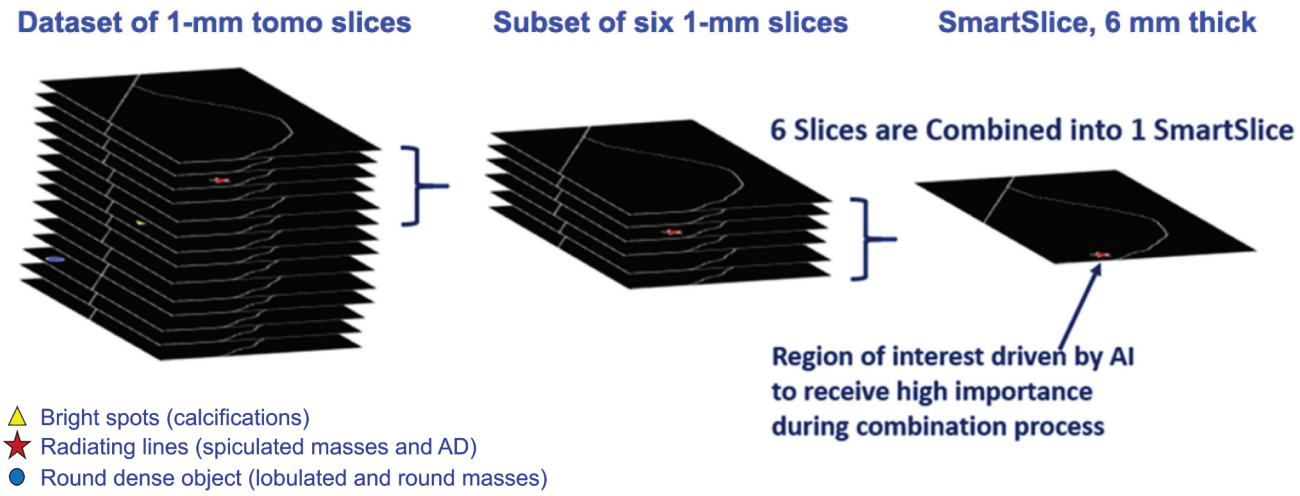


Figure 1. *Six 1mm slices are combined into one 6mm SmartSlice, giving extra weight to AI-located objects of interest.*

contrast resolution on the synthesized Intelligent 2D™ images. Machine learning technologies create computer-generated version of conventional 2D mammograms. Using Intelligent 2D technology reduces radiation exposure by 50% by eliminating a conventional 2D exposure.[3]

Synthesized 2D views generated from the raw 3D™ dataset have traditionally been plagued by poor spatial and contrast resolution. Intelligent 2D images show vast improvements on both fronts, with the synthesized view finally beginning to resemble the appearance of a conventional 2D exposure (Figures 3 and 4). Calcifications have a more discrete appearance and are often more salient on the synthesized view when compared to a conventional 2D exposure (Figure 5).

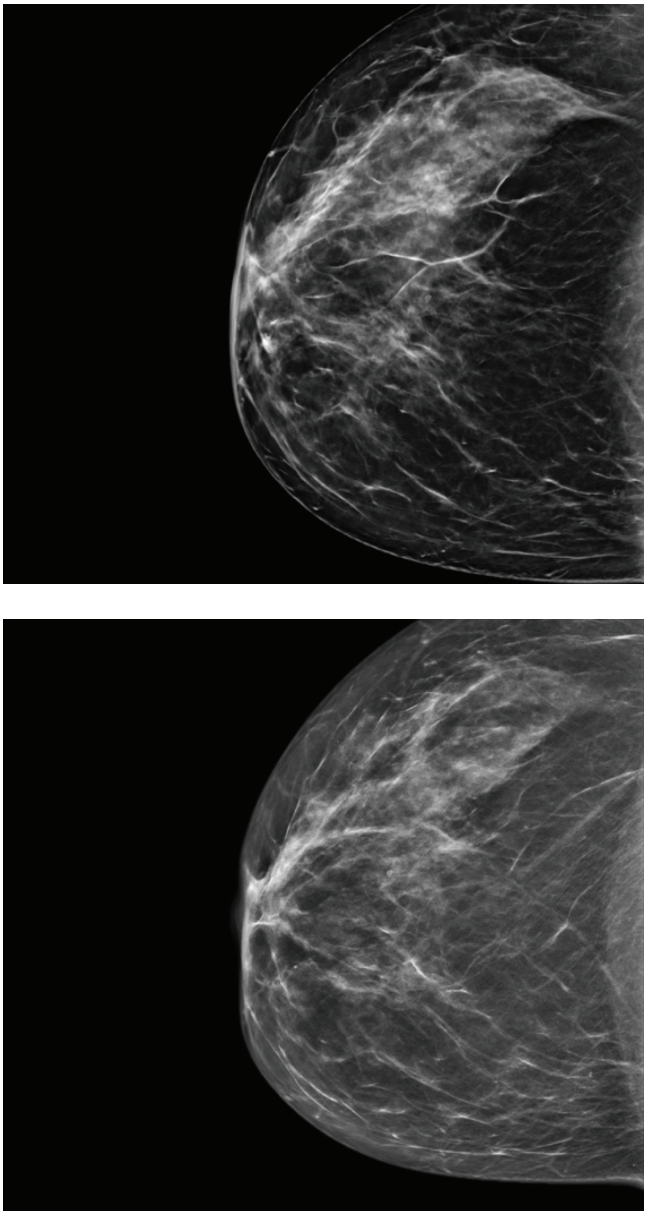


Figure 3. *Top: RCC Intelligent 2D view. Bottom: RCC VP synthetic 2D view.*

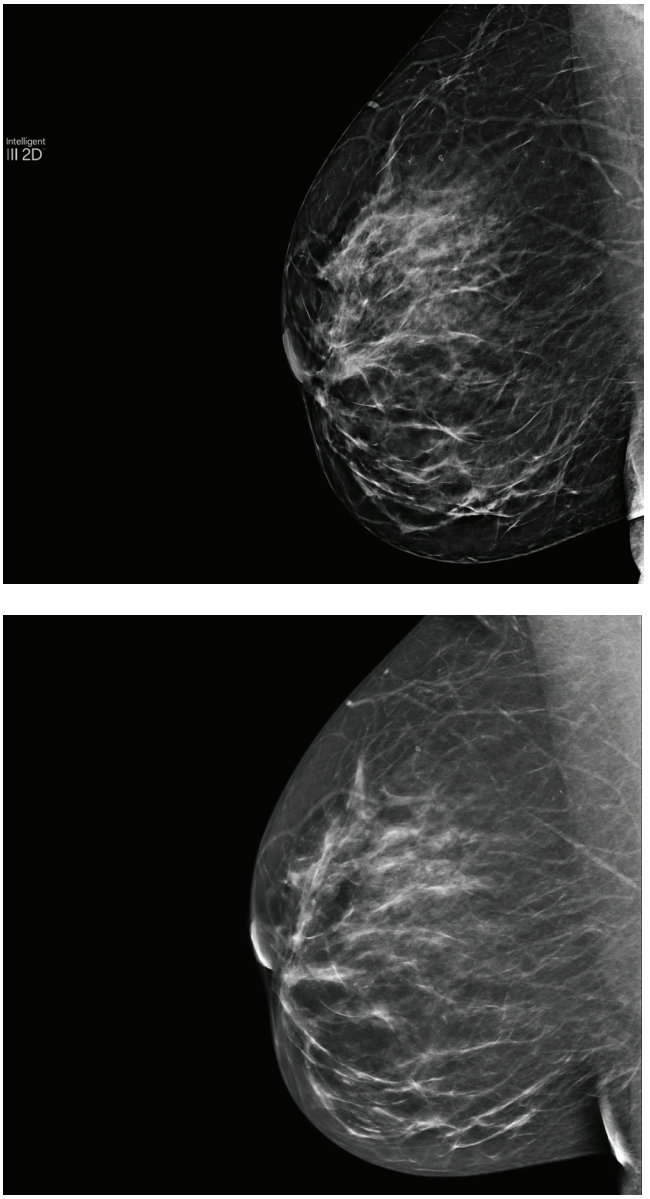


Figure 4. *Right: RMLO Intelligent 2D view. Left: RMLO VP synthetic 2D view.*

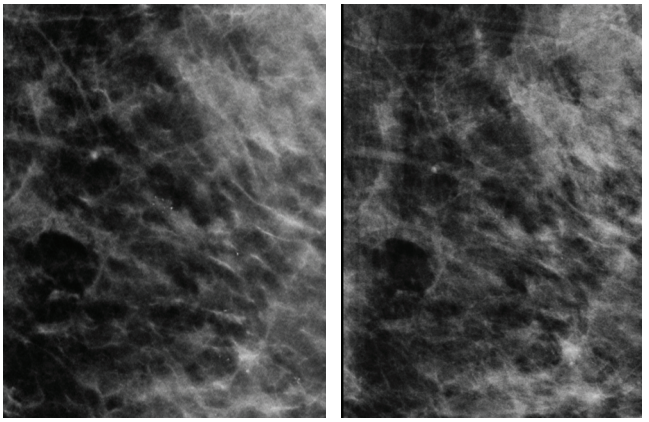


Figure 5. *Left: L MLO I2D Intelligent 2D View. Calcifications appear more conspicuous. Right: L MLO Conventional 2D exposure. Calcifications appear less conspicuous.*

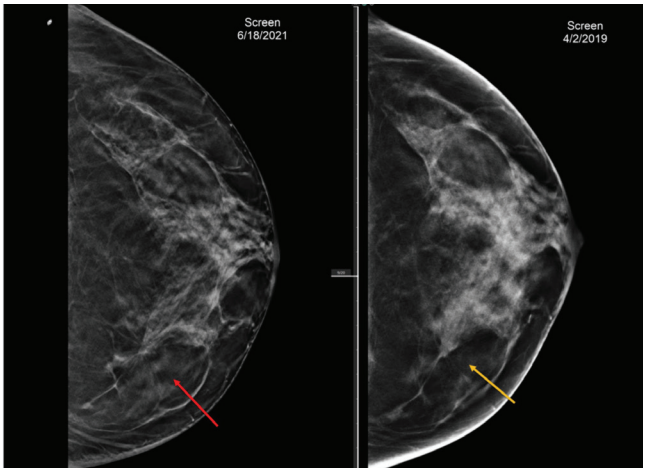


Figure 6. *Case 1: Spicules associated with left inner breast distortion appear more vivid on the current exam (red arrow) compared to prior (yellow arrow).*

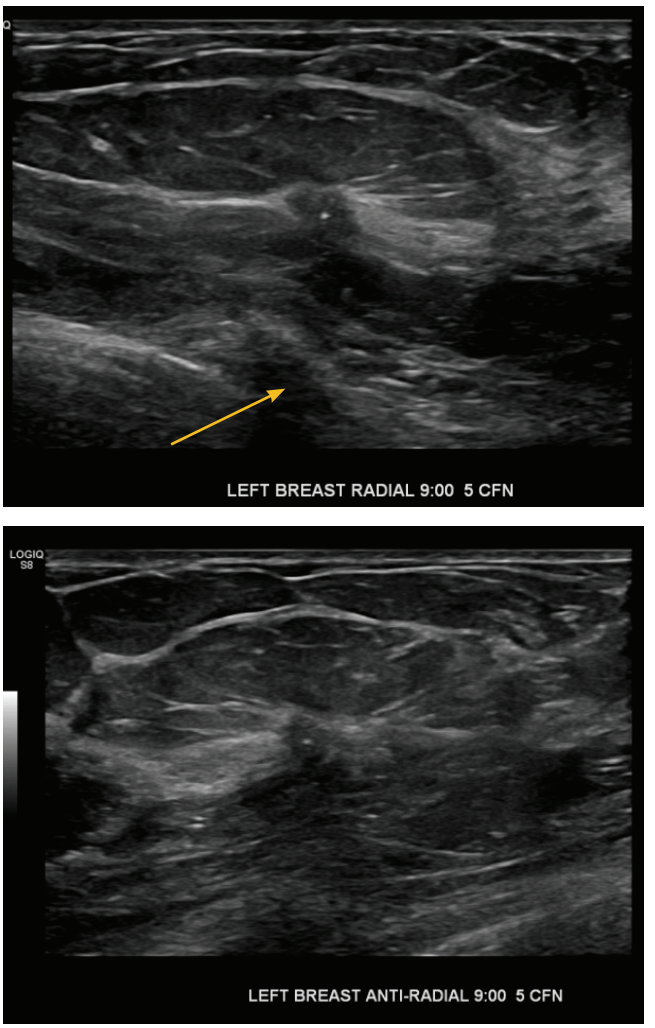


Figure 7. *Case 1: L9N5 9 mm mass confirmed on ultrasound. Pathology: Well-differentiated Invasive Ductal Carcinoma and low-grade Ductal Carcinoma In Sutu.*

Compelling Findings

What about the 3D dataset? Is any information lost in translation from the raw data to the SmartSlices? Given the impracticality of contemporaneously scanning our patients on two different mammography units, the answer to this question could best be gleaned by comparing findings that have been relatively stable across time and imaged on both units. In a few cases the findings were quite compelling.

Case 1: This demonstrates an architectural distortion in the left inner breast that only in retrospect was likely present on an exam two years prior. The associated radiating lines appear more discrete on the current exam when compared to the prior exam. These features prompted a biopsy recommendation with the pathology yielding well differentiated invasive ductal carcinoma (Figures 6 and 7).

Case 2: There is a stable benign appearing mass within the right breast central-inferior aspect at middle depth that appears obscured and partly indistinct on the prior exam. Note the circumscribed margins on the current exam that inspires confidence in the resultant benign diagnosis (Figure 8).

Case 3: In this case, a mass, unchanged in size across two years, demonstrates subtle spiculation and distortion (note straight lines radiating outward from this finding) on the current exam with Clarity HD technology and 3DQuorum

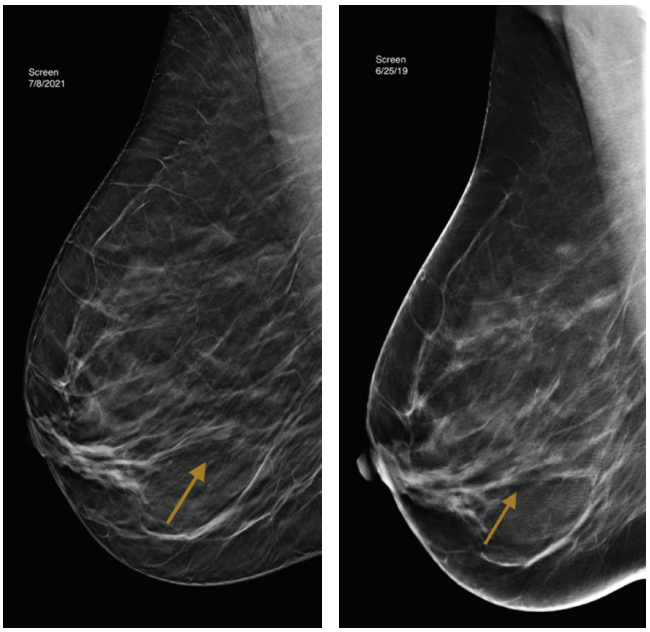
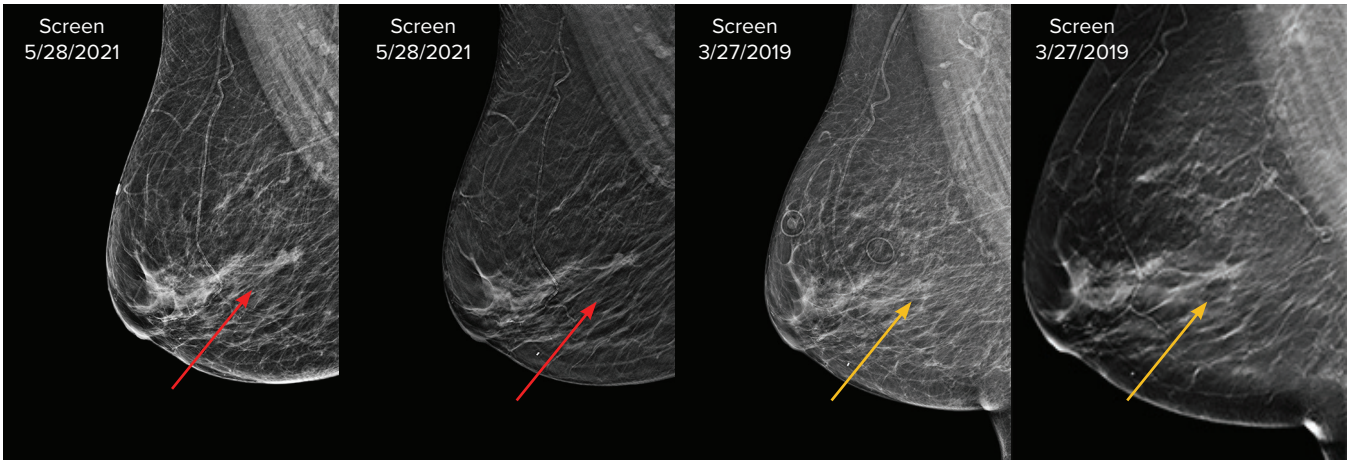


Figure 8. *Case 2: Routine Screen. RMLO stable, benign appearing mass appears more distinct on current exam utilizing SmartSlices.*



- Mass stable in size over 2 year, demonstrates subtle spiculation on current exam prompting biospy recommendation
- Path: Invasive Ductal Carcinoma, Moderately Differentiated

Figure 9. *Case 3: 78 F history of L breast cancer status post mastectomy presents for annual R mammogram.*

SmartSlices as compared to the innocuous appearance on the 3D™ exam two years prior. Typically, findings demonstrating 2-year stability are conferred a BIRADS 2 designation and deemed benign. However, the subtle appearance of the associated distortion and spiculation with this mass prompted a biopsy recommendation, which yielded moderately differentiated invasive ductal carcinoma. While it is speculative to suggest that these features may have been present on the prior exam but not visualized because of different technology, it stands to reason that such a lesion, unchanged in size, likely had irregular and spiculated margins at its origin (Figure 9).

Conclusion: A Substantial Impact

As the wheels of progress propel us through new frontiers of medicine and technological advancement, we are perpetually confronted with the disquieting prospect of uncoupling ourselves from the familiar and embracing the unfamiliar. Such was the case with our recent migration to Hologic Clarity HD with Intelligent 2D and 3DQuorum technology. Although the changes may have been subtle, the impact has been substantial. Improvement in spatial resolution augments our ability to evaluate the anatomy, discriminate malignant from benign and offers enhanced diagnostic accuracy.

Synthesized 2D images now more closely resemble the conventional 2D exposure, with calcifications not only mirroring that seen on conventional 2D mammography, but also becoming more salient on the optimized Intelligent 2D synthesized image.

Integration of artificial intelligence into the breast imaging paradigm may be the most innocuous yet most profound of all the advances witnessed with this recent change in platform. The 3DQuorum algorithm powered by Genius AI technology pares down what would otherwise be a voluminous and untenable dataset into one that is palatable for our PACS and network systems and more easily interpreted by radiologists with reduced turnaround time, fatigue, and digital eye strain.

Radiology stands on the cusp of a new frontier in which radiologists synergize their interpretive skills with computer algorithms. Integration of Hologic's Genius AI™ technology into our breast imaging paradigm is to my knowledge the first such system-wide advancement utilizing artificial intelligence and may very well herald this new era in which both human and artificial intelligence coexist harmoniously in a reading room.

Looking back, the change to the 3Dimensions systems with high-resolution imaging, Intelligent 2D technology and 3DQuorum SmartSlices was worth the investment.

About the author

Jason McKellop, MD is a board-certified radiologist with fellowship training in breast imaging. Dr. McKellop has a passion for providing high quality, evidenced-based, patient-centric care with a focus on reducing breast cancer related mortality.

"Be not afraid of growing slowly; be afraid only of standing still" – Chinese Proverb

References

1. Hologic data on file: CSR-00116
2. Physician Labeling: MAN-06153
3. Hologic data on file: DHM-00501

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