Innovations in breast ultrasound imaging

Improving diagnosis, workflow, and therapy monitoring

Who/Where:
The Breast Cancer Prevention Center and the University of Kansas Hospital Cancer Center at the The University of Kansas Medical Center (KUMC), Kansas City, Kansas

Challenges:
Difficulty in making ultrasound diagnoses in women with dense and fatty breast tissue; the need for enhanced ultrasound image quality in characterizing breast lesions; and the need for increased patient throughput to meet the growing demand for breast ultrasound exams.

Solution:
Philips continues to expand the capabilities of the premium iU22 platform. Vision 2009 is the 4th major upgrade, focusing on helping care providers achieve diagnostic certainty, and improve workflow and throughput with the latest cutting-edge imaging and quantification capabilities.

The University of Kansas Medical Center (KUMC) is a major research institution and a leader in the development of research, education and patient care programs. A critical area of focus at KUMC is the diagnosis and treatment of breast cancer.

With their focus on the diagnosis and treatment of breast cancer, KUMC's major challenge has been increasing the accuracy of breast lesion assessment. Clinicians needed better quality ultrasound images to make more accurate diagnoses, as well as to assess therapy once treatment began.

Breast cancer

Breast cancer is the most frequently diagnosed cancer in women. It is difficult, however, to find and assess breast cancer early in women whose breast tissue is dense or fatty, often hiding suspicious lesions. Mammography has been the traditional modality in diagnosing breast cancer. However, it is challenging for mammograms to image through dense breast tissue in order to assess the size of a tumor and to evaluate the stage of the disease.

Breast ultrasound in the care cycle

Physicians typically use ultrasound to evaluate breast abnormalities that have been found with screening, diagnostic mammography, or during a clinical breast exam. Ultrasound may help detect some breast masses. It is also the best way to determine whether a cyst is present without placing a needle to aspirate fluid. Ultrasound can also help physicians guide a biopsy to determine whether a breast abnormality is cancerous. Used during core and fine needle aspiration (FNA) biopsies, ultrasound helps determine where to place the needle. It may also be used to prove whether a suspicious area is a lymph node, as lymph nodes have fatty centers which are often apparent on ultrasound.

Ultrasound has not been used for routine breast cancer screening because of difficulty in detecting certain early signs of cancer, such as microcalcifications. A cluster of microcalcifications (tiny deposits of calcium in the breast that cannot be felt, but can be seen on a conventional mammogram) may indicate that cancer is present.

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"The improved image quality that 3D ultrasound provides also has in some cases changed the diagnosis of a breast lesion."

However, ultrasound has been shown be a highly-effective tool in the diagnosis, staging, and biopsy of breast tumors. It provides excellent data for assessment of the size and stage of tumors seen on a mammogram, even when imaging through dense breast tissue.

Improved imaging despite fatty and dense breast tissue

The early diagnosis of breast cancer by ultrasound can be difficult due to the similar reflectivity indices of fat and malignant tissue. Clinicians at KUMC were finding that they needed improved lesion detection in patients with both fatty breast tissue, typical in older women, and dense breast tissue where the detection of cancer can be more difficult.

Philips has addressed this issue by implementing unique user-selectable tissue aberration correction (TAC) algorithms that compensate for alterations in the speed of high frequency sound waves through breast tissue. Available on the L12-5, L17-5 and new VL13-5 transducers, TAC results in increased image sharpness and clarity in patients with a spectrum of fatty and dense breast architecture. "We have found that speed of sound imaging can enhance lesion detection and can be prioritized so as to get the best images possible in staging cancer," said William P. Smith, MD, RVT and Director of Breast Imaging at KUMC.

Advanced XRES imaging has been added to the L12-5, L17-5 and VL13-5 transducers, further optimizing the image in real-time to enhance B-mode image quality with superior detail resolution for excellent imaging of the breast, thereby improving detail resolution.

Improved imaging of microcalcifications

Ultrasound has traditionally been unable to clearly image microcalcifications, which are often the first indication of breast cancer. Since implementing the Philips iU22 Vision 2009 platform with improvements in the L12-5 and L17-5 2D transducers, as well as VL13-5 volumetric transducer, KUMC is realizing significant improvements in their ability to identify microcalcifications.

"I've seen a noticeable improvement using Philips L12-5 and L17-5 2D transducers and VL13-5 3D imaging," said Candace Spalding, RDMS, RVT, RT, Ultrasound Supervisor and Co-Program Director of Ultrasound Program. "With the Vision 2009 upgrade, we have been able to better delineate and visualize microcalcifications, which is a vast improvement in that the ultrasound demonstration of microcalcifications can be an early sign of a suspicious mass in the breast."

"Moreover, the uniformity of the image is awesome. The way the far field matches the near field, the way images are created that are consistent, dependable, and diagnostic makes it a delight to use. I'm thrilled to use this tool," added Dr. Smith.

Vision 2009 helping improve tumor assessment

Since implementing Philips iU22 Vision 2009 platform, KUMC is realizing significant improvements in image quality—helping KUMC's clinicians to better characterize lesions in making cancer diagnoses and assess tumors during therapy.

"We have learned, and are continuing to learn, that cancer spreads in an unusual manner, and the coronal plane (c-plane) tends to be prioritized as cancers grow.

William P. Smith, MD, RVT and Director of Breast Imaging at KUMC

The c-plane images most accurately display the tumoral growth patterns. Therefore, the margins acquired in that plane are hopefully the most accurate measure of breast cancer growth, and the most accurate measurement of the response to treatment," states Dr. Smith.

"We are learning daily about tumoral growth patterns and the way cancers spread," stated Dr. Smith. "For example, we now know that 25-35% of the time, when there's a known cancer, we have additional cancers in that same breast. These are often smaller and less conspicuous, and until now have been challenging to visualize."

"We have taken 3D imaging and done a more accurate job of defining tumoral margins. In other words, microlobulations, tumoral septations, and the spiculations surrounding a tumor are now more accurately displayed and measurements have inherited that accuracy."

Dr. Smith adds that the improved image quality that 3D ultrasound provides also has in some cases changed the diagnosis of a breast lesion.

"3D imaging has allowed us to more accurately measure each cancer and find out what its absolute diameters are so as to accurately stage these cancers and hopefully use these measures to assess therapy."

Volume imaging and the need for more diagnostic data

Vision 2009's 3D or volume imaging enhancement is improving image quality by enabling clinicians to better distinguish between cystic and solid masses, and benign and cancerous tumors, as well as to view breast cancer spread with greater accuracy.

"3D imaging is giving clinicians access to a whole new level of information in viewing and assessing masses," said Dr. Smith. "We can use volume or 3D imaging to prioritize the acquisition to optimally show the full extent of the tumor. Theoretically, and in practice, that results in a more adequate resection of cancer, a more thorough surgical intervention, and more adequate pre-operative planning."

Dr. Smith says that using Philips VL13-5 transducer has been a tremendous asset in allowing clinicians to acquire a volume image to better characterize a lesion.

"The VL13-5 volumetric transducer will help us improve throughput by using the transducer to augment our scan. If it's a targeted area, we'll image that area, do multiple 3D acquisitions of that area, and feel comfortable that we've acquired the data that we need so the patient can leave," explains Spalding. "The radiologist and sonographer can review the data offline and see if we need to do anything else. Knowing the data is stored in the system, and that we can review and manipulate the images later is very positive. I think that's where the volumetric transducer is going to benefit our lab."

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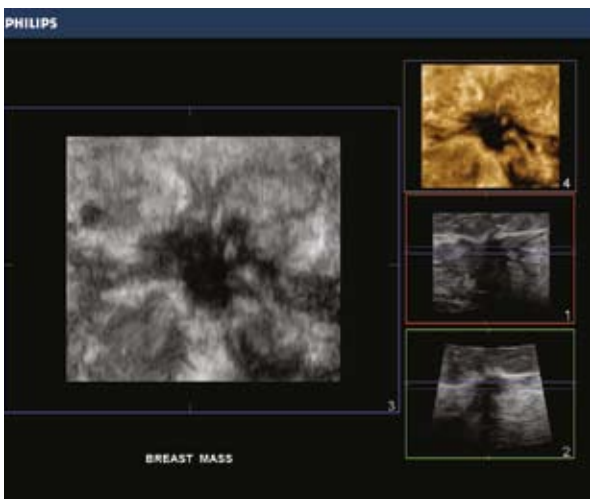
Future of 3D imaging in therapy monitoring

As a result of the improvements in volume quantification tools, clinicians can see first-hand the effect of treatment on a mass and quickly assess treatment.

"We also need a more effective way to determine the success of treatment, particularly in the preoperative, neo-adjuvant period," commented Dr. Smith. "Using traditional breast exam methods are not an accurate assessment of treatment. A successfully treated tumor may rapidly swell, which can be misinterpreted as a failed chemotherapeutic effort when in fact it's a rapid death of a primary index cancer, mimicking rapid growth when, in truth, it is only edema."

"The use of volume quantification tools is an area in which I have a great deal of interest. The University of Kansas is fortunate to have a very successful neo-adjuvant therapy protocol, which means cancers are treated with medications, chemotherapy prior to surgery. We're very excited about this in that it is incumbent upon breast imagers to see if the cancers are getting larger or shrinking during their preoperative chemotherapy



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"Vision 2009 has improved our throughput by approximately 10-20%."

Improving workflow, reducing exam times

"One of the most important issues that our lab was facing was being able to perform more breast ultrasound exams with fewer sonographers, while also increasing patient throughput," reports Spalding. "This puts a lot of stress on our sonographers, who are expected to scan more, while acquiring quality scans in less time. This is really hard to do when you're imaging the breast. We needed to improve our workflow to handle these demands."

Philips iU22 with Vision 2009 offers new SmartExam system-guided protocols to specifically address speed and consistency of exams. It includes features such as exam record, support for 3D, and automatic mode switching, which are helping to enhance KUMC's workflow. "Vision 2009 has improved our throughput by approximately 10–20%. It's helped us a great deal. Until now, protocols in imaging have depended upon repetitive typing of a location in the breast, centimeters from the nipple, the orientation, it being radial or anti-radial," said Dr. Smith. "We tried to calculate the number of keystrokes that go into labeling a single breast, and my guess is it's about 100. Worse yet, sonographers can skip key areas. If they are prompted by a screen-driven message they will not have to waste time labeling, and we will gain that time in accurate, motivated imaging."

"SmartExam is an awesome tool for the annotation package," said Spalding. "We use SmartExam to do global breast ultrasound. We have a protocol setup, and each sonographer in the lab follows the same protocol, so we have consistency in our lab, which is very important. Basically, the most important feature of SmartExam is that sonographers don't have to look away from the monitor. They can keep the flow going, transitioning from one quadrant to the next, knowing that they have obtained all the images, and that they will not be sent back in to obtain others."

effort. Volume imaging allows us to predict the success of a chemotherapeutic effort based upon very subtle changes in the volume of a mass. Theoretically, if it shrinks five percent 48 hours after that first dose of chemotherapy, we can optimistically encourage continued chemotherapeutic regiments and not change them. If the tumors get larger shortly after their first neo-adjuvant chemotherapeutic effort, then oncologists might consider changing or altering therapy, or adding different drugs to fit the markers we provided them preoperatively."

"It is very exciting for me to be a part of this effort. Vision 2009's many new features allow us to better characterize lesions before and after treatment, giving me a more accurate measurement tool to convey to the oncologists that their efforts are working."

With respect to monitoring therapy in progressive cancer, Dr. Smith feels 3D ultrasound has the potential to play an important role. "Subtle changes in a solid mass's volume are very complicated. A very small decrease in the diameter of a mass results in a significant decrease in the volume. Therefore, imaging has to lead us through this difficult passage by detecting in a consistent, reproducible way, very early subtle changes in the overall thickness of the mass that will equate to a decreased volume and allow us to have more confident patient management."

Dr. Smith is enthusiastic about Philips Healthcare's contribution to breast imaging. Overall, Philips iU22 with Vision 2009 features is giving KUMC a valuable tool that helps clinicians better characterize breast lesions to improve breast cancer diagnoses and monitoring of tumors post-therapy.

"Philips is the pioneer in this field. I have been delighted at the response Philips has provided in this volumetric quest. The transducer is delightful, balanced, and can be utilized to acquire data sets very, very quickly."

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