

Volume Ultrasound and Volume Imaging Protocol in breast imaging.

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Introduction

Breast cancer is the most common, life-threatening cancer among women in the United States¹. In 2005, it is estimated that about 212,000 new cases of invasive breast cancer will be diagnosed, along with 58,000 new cases of non-invasive breast cancer, and 40,000 women are expected to die from this disease. Breast cancer incidence in women has increased from one in 20 in 1960 to one in seven today. Benign and malignant breast tumors can have many different presentations, and characterizing them is not an easy task.

Ultrasound is primarily a method for differentiating cystic from solid lesions. Some believe they can use ultrasound to distinguish some benign from malignant masses by visualizing structural characteristics.²

3D ultrasound and breast imaging

There has been increasing attention given to 3D breast ultrasound as an adjunct to mammography. Benefits of accessing more information from the 3D data set and the ability to view the non-traditional scanning planes contribute to the rising interest. In particular, the 3D planar views are said to be helpful when studying tumor margins and ductal structure.

Ductal interrogation and DCIS

Ductal carcinoma in situ (DCIS) is the precursor of the majority of invasive breast cancers.³ When referring to ultrasound examinations of the dense breast, Dr. Rizzato wrote, "high-resolution sonography can demonstrate the intraductal spread of tumors and their multiple foci more easily than mammography."⁴ Carefully interrogating suspicious areas along known disease origins and growth patterns is

instrumental to the breast ultrasound exam and helping to expose cancer in its earliest stages. The majority of DCIS lesions originate from the terminal ductal lobular unit.⁵ Conscientious scanning and gathering the most information possible in these problematic areas should be the protocol.

In the past, ultrasound was limited to conventional scan techniques and the coronal plane was not available for viewing. Increasingly, the coronal plane is showing new and beneficial diagnostic information. Ductal branching has a complex pattern; therefore, intraductal spread and multifocal nodes are better demonstrated by multiplanar analysis of 3D ultrasound data volumes. Sonography can easily explore the different nodal chains.⁶ Ultrasound is essential in helping differentiate between pathologic and normal ductal structures.

In addition, when sonography is performed for bloody discharge, dilatation of one or a few ducts in one quadrant is a serious finding. If a sonographic intraductal or intracystic mass is identified, then biopsy or excision may be indicated.⁷ The coronal view of the breast allows the evaluation of a duct or multiple ducts displayed lengthwise via that 3D plane. Looking at the ducts in this manner along with the 3D volume data set gives the physicians more information for the diagnosis.

Borders, margins and tumor extent

Some of the advantages of 3D ultrasound include:

- breast tumor treatment, planning and monitoring
- skin tumor infiltration evaluation
- 3 planes to define margins, i.e., microlobulation, papillomas
- extra information seen in the B and C planes that would otherwise be missed in 2D (A plane)
- visualization of C plane to view compression versus retraction patterns of tumors.⁸

The importance of meticulously examining the breast in every possible plane, with special attention to the ductal structure and the borders of tissue in question, could be imperative and crucial to defining and classifying certain breast masses.

The following case illustrates the usefulness of 3D Volume Ultrasound and Volume Imaging Protocol (VIP) scanning by providing critical diagnostic information for the reading physician and surgeon, more clearly defining the extent of the disease process and adding to the treatment and surgical planning process.

A case study – Volume Ultrasound in breast imaging

Clinical history

A 41-year-old female patient presented with enlarged right axillary lymph nodes. The mammogram study showed the presence of multiple spiculated masses in the right breast, as well as, malignant casting type microcalcification. A nodule was seen on the left. Bilateral ultrasound was requested for further evaluation.

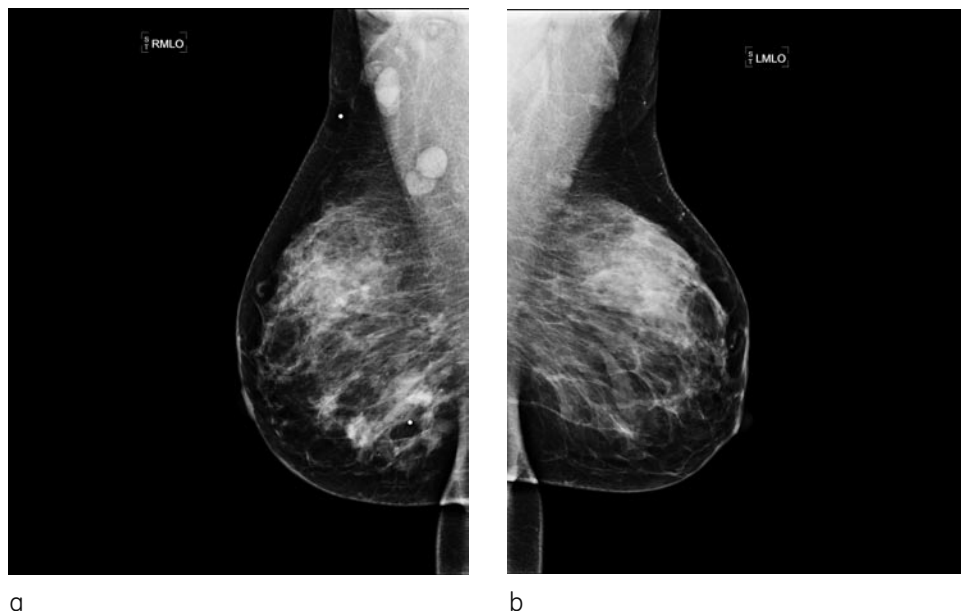


Figure 1 Mammography images. Right (a) and left (b) breast.

2D ultrasound findings

Real time ultrasound of the right breast suggested multiple invasive cancers. The presentation of the masses included: irregular contours with calcifications, hypoechoic with posterior attenuation, solid, mass extending to the skin surface, heterogeneous with spiculations and solid intraductal filling defects, most of which are consistent with malignancy.

The left breast contained three areas showing apocrine metaplasia, hypoechoic, well-defined nodules and an intraductal filling defect.

Ultrasound images

Volume Ultrasound and the Volume Imaging Protocol

A 3D data set is acquired in approximately 2-4 seconds, with a volume sweep on GE's LOGIQ® ultrasound systems. The 3D volume can then be thoroughly examined in any plane on the LOGIQworks™ off-line system, even after the patient has gone. VIP scanning utilizes the entire volume of data. This provides the ability to virtually rescan an area of concern and navigate through the 3D volume data set, potentially eliminating the need to call the patient back for another scan.

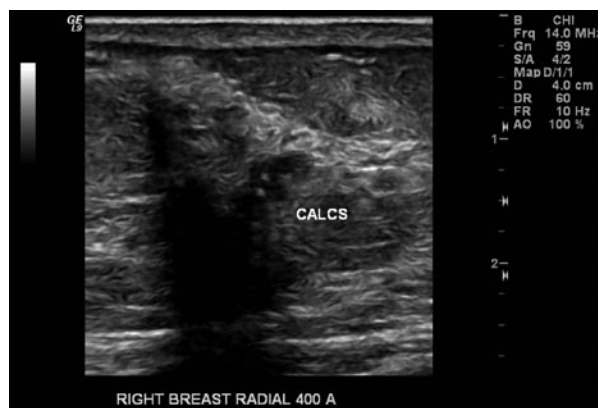


Figure 2 Malignant characteristics of a mass in the right breast.

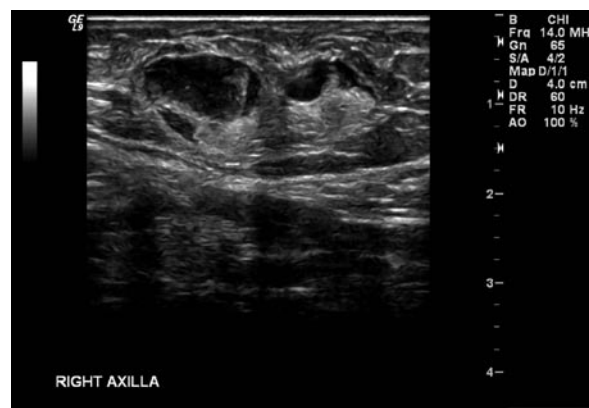


Figure 3 Involved lymph node right axilla.

VIP case study

In this case study, the volume acquisitions were performed with a M12L transducer and the LOGIQ 9 ultrasound system (GE Healthcare, Milwaukee, USA). The virtual rescan and volume navigation were performed on the LOGIQworks (GE Healthcare, Milwaukee, USA). A free hand volume sweep of the anatomy was the acquisition method.

Using the 3D volume information and raw data processing, the structure and origin was demonstrated, and the borders of these masses delineated. The capability of using raw data to manipulate parameters such as overall gain, Time Gain Compensation (TGC), dynamic range and 3D navigation, delivered the opportunity to increase the confidence of the initial diagnosis because it allowed the user to improve those fine details needed when making the diagnosis.

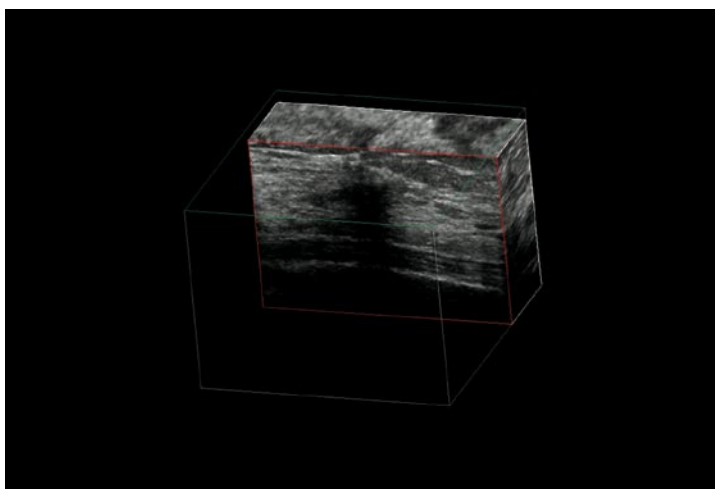


Figure 4* and Figure 5 3D cube A plane views of a suspicious area.

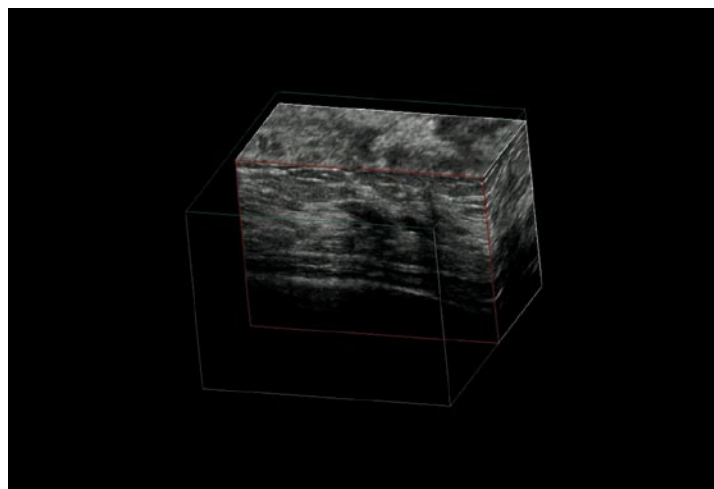


Figure 5*

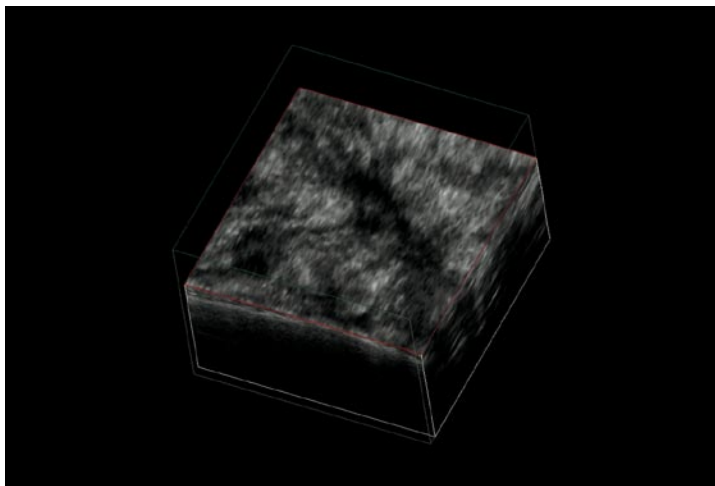


Figure 6* and Figure 7 Coronal (c) plane views of the suspicious areas demonstrated in Fig 4 and 5. The coronal plane shows retraction patterns, spiculations and possible bridging of the lesions with a detailed view of the extent of the involved area. This view cannot be obtained with a normal 2D exam.

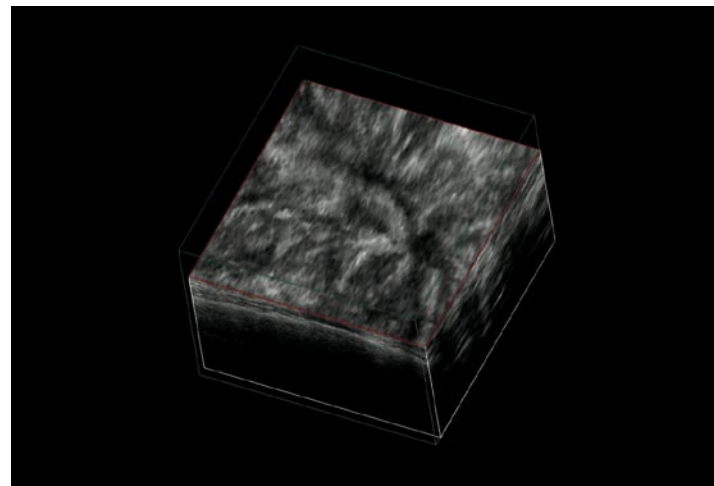


Figure 7*

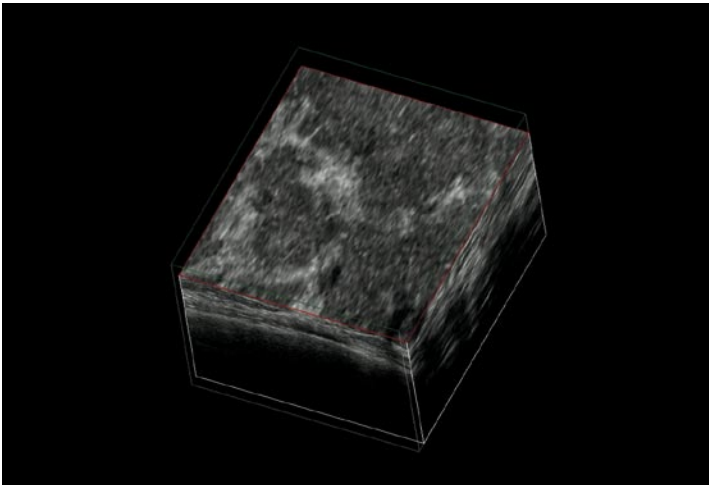


Figure 8* Normal breast tissue coronal plane.

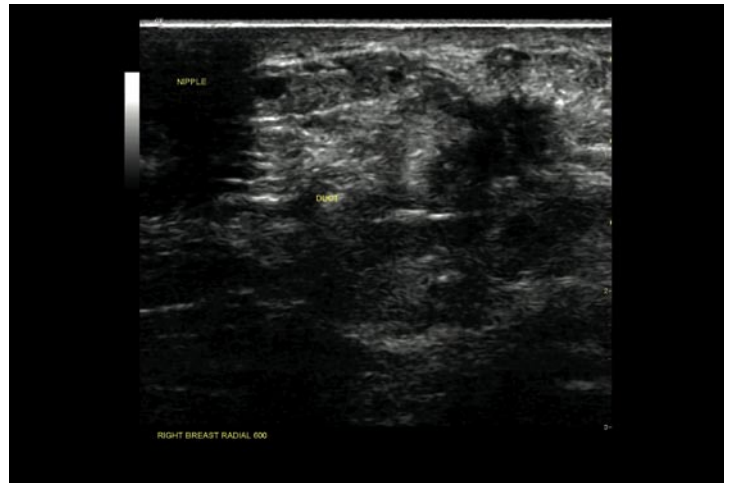


Figure 9 Right breast view shows ductal involvement of DCIS. (Proven later by ultrasound guided core biopsy)

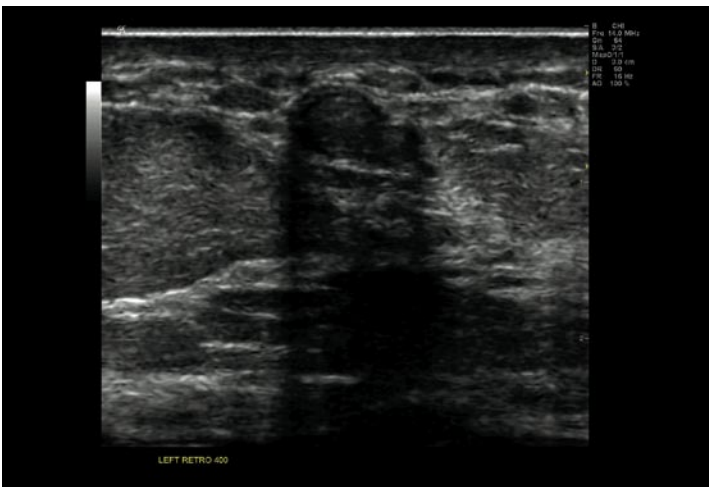


Figure 10 2D view of the ductal filling defect, in left breast.

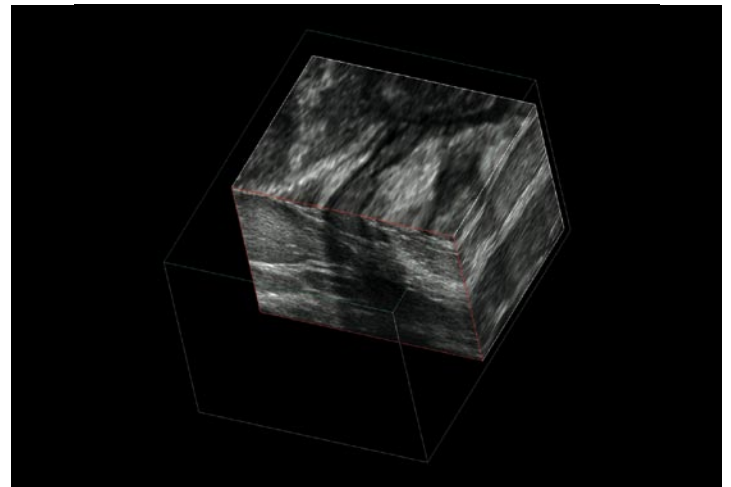


Figure 11* 3D view of the coronal plane of Fig 10, showing the solid extent of the ductal involvement.

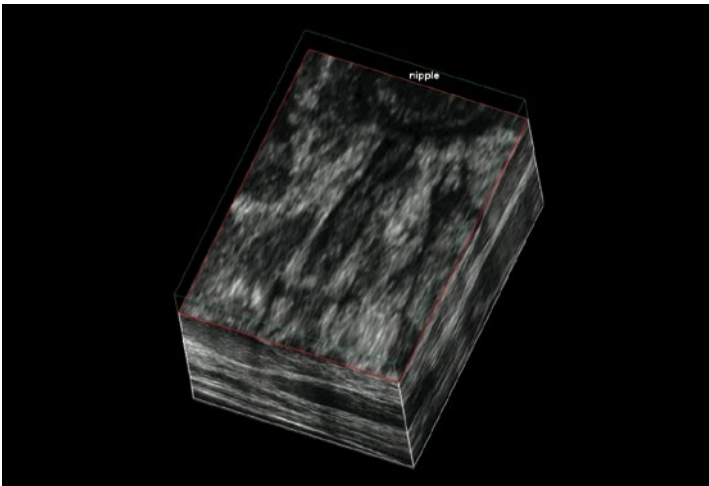


Figure 12* Coronal view of ductal filling defect.

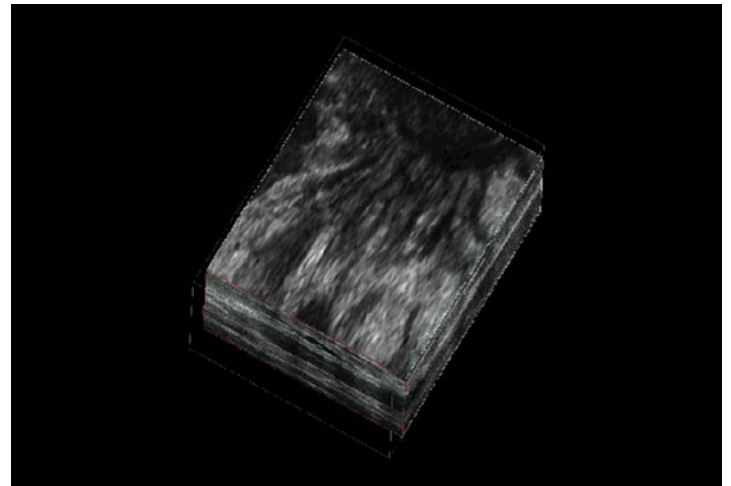


Figure 13* Coronal view of multiple dilated ducts to nipple.

See back panel for Conclusion.

* These views were obtained on the LOGIQworks system.

Discussion

3D volume data and the coronal plane imaging provided more detailed information about lesion characteristics, extent and borders. Multiple findings such as the retraction patterns, spiculations and possible bridging between the masses, along with the ability to interrogate numerous ducts in any plane, was enabled by VIP volume scanning and demonstrated especially in the coronal views, which could not be displayed in normal 2D imaging.

Conclusion

Volume Imaging Protocol enables viewing of the entire volume data set in addition to the coronal and out-of-plane views, providing access to a new look at breast pathology and disease processes, that 2D conventional scanning has not previously allowed.

Ongoing 3D research is in progress to aid in earlier detection of breast cancer. 3D Volume Ultrasound, which offers the ability to perform volume navigation and the virtual rescan, is demonstrating anatomy in ways which allow more complete coverage of the areas of interest. This gives the power to thoroughly investigate lesions in any plane, even after the patient has gone. 3D volume ultrasound was shown to be a powerful adjunct to 2D breast ultrasound, adding beneficial diagnostic information compared to the 2D scan alone.

Diagnosis and treatment of breast cancer in its earliest detectable phases results in dramatic improvement in the outcome of the breast cancer patient.⁹

GE Healthcare is striving to help find ways to enhance the diagnostic process.

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imagination at work

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