Mammography; A Women Companion That Saves Lives

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What is Mammography?

The objective of Mammography is the early detection of breast cancer, typically through the discovery of characteristic masses and/or micro calcifications. The mammography procedure consists of compressing the breast between two plates: the compression plate and the detector. The aim is to even out the thickness of the breast tissue to increase image quality by reducing the thickness of tissue that x-rays must penetrate, decreasing the amount of scattered radiation (scatter degrades image quality), reducing the required radiation dose, and holding the breast still to prevent motion blur.

The Screening Mammography detects the presence of cancer in women who have no symptoms or observable breast abnormalities. It is required after a certain age when no clinical signs are noticeable. It includes four x-ray images; two for each breast, the Cranio-Caudal CC (head to foot) view and the Medio-Lateral Oblique MLO (angled to side) view.

The Diagnostic Mammography is used to diagnose suspicious findings on a screening mammogram or suspicious breast changes, such as breast pain, unusual skin appearance... it is also used on patients with breast implants, breast reductions, and patients with personal and/or family history of breast cancer. It includes additional mammogram images, including geometrically magnified and spot-compressed views of the particular area of concern.

How frequent should we do Mammograms?

The American College of Radiology and American Cancer Society recommend yearly screening mammography starting at age 40. The U.S. Preventive Services Task Force (2009) recommends having Mammograms every two years between the ages of 50 and 74. The Canadian Task Force on Preventive Health Care (2012) and the European Cancer Observatory (2011) recommend mammography every 2 to 3 years between the age of 50 and 69. These reports also point out that if more frequent mammograms are done, more than what is recommended and without any medical need, this may encourage a small but significant increase in breast cancer induced by radiation.

What are the different new Technologies available?

Mammography has a known but acceptable false-negative (missed cancer) rate of at least 10 percent. This is partly due to dense tissues obscuring the cancer. The utilization of proper and advanced technology is a necessity to detect early cancer, and reduce false-negative reports. We need to acquire the necessary technology to have extraordinary sharp image details, which help us better visualize masses, distortions and asymmetric densities for more clear diagnostic rulings. We need a system designed as a single platform to provide an efficient solution for any breast imaging need. A summary of the essential technical leads for an advanced Mammography new system are:

- FDA and CE approved Mammography and Tomosynthesis unit
- Tomo images in all views.
- Direct conversion detector with the smallest pixel size (70µ)
- Fast acquisition time and Fast reconstruction time
- Better resolution (15 low dose projections reconstructed in 1 image)
- Less pain (less compression, bending compression plate)
- Less dose (2D image is reconstructed from 15 low dose projections)
- Less false positives and less false negatives with maximal safety.

We have the options of choosing between four different systems: conventional Analog system (not recommended any more), conventional Digital mammography only, Tomosynthesis imaging only, or a combination of digital mammography and breast Tomosynthesis under one compression (also known as combo mode). When a screening exam is performed in combo-mode, the breast is compressed in the normal way. At the start of the exam, the X-ray tube first sweeps in a 15-degree arc over the breast to acquire a series of 15 low-dose projection images at multiple angles. These projection images are mathematically reconstructed into a 3D breast image. Immediately following the Tomosynthesis scan, the High Transmission Cellular (HTC) grid automatically comes into the imaging field, and a conventional digital mammogram is acquired. This complex operation is completed in just seconds, giving the radiologist both a 2D mammogram and a Tomosynthesis scan, under the same compression, for perfectly co-registered images.

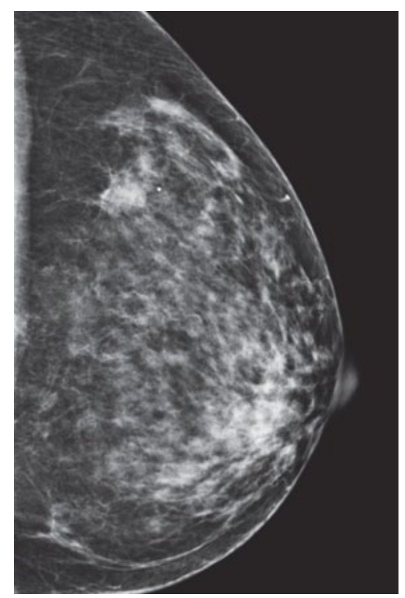
Unlike prior-generation mammography systems which generate two-dimensional (2D) images, a breast Tomosynthesis system produces three-dimensional (3D) images which are intended to reveal the inner architecture of the breast, free from the distortion typically caused by tissue shadowing or density.

By using Stereotactic biopsy and 3D radiologists can locate and accurately target subtle regions of interest that may only be visible under 3D imaging. The 3D mammography has shown that the Positive Predictive Value (PPV) for biopsy increased by 20%. The 3D biopsy procedure offers a number of advantages over stereotactic biopsy procedures, including:

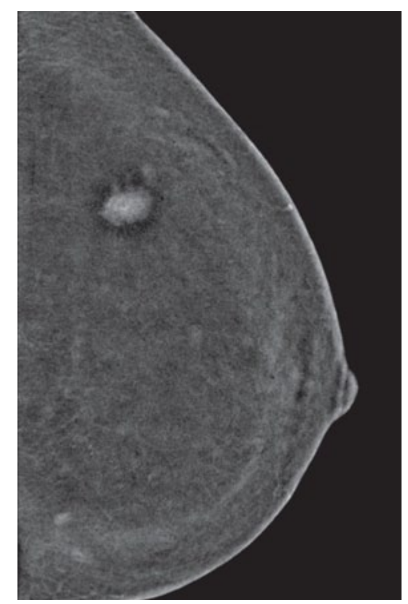
- Optimized workflow: Fewer procedure steps and 13 min procedure time.
- Low Dose: 3D eliminates exposure steps resulting in reduced patient dose.

The new technology High Transmission Cellular (HTC) grids have been shown to significantly reduce scattered radiation in mammography. This has been achieved with essentially the same patient dose as compared with a conventional 5:1 ratio linear grid. Consequently, images produced with the HTC grids have significantly higher subject contrast than those produced with conventional grids. A result of the increase in subject contrast is the perceived increase in sharpness of small details such as micro-calcifications, speculations, etc. The HTC grids showed a higher Contrast Improvement Factor as compared with a conventional linear grid, resulting in highly improved imaging.

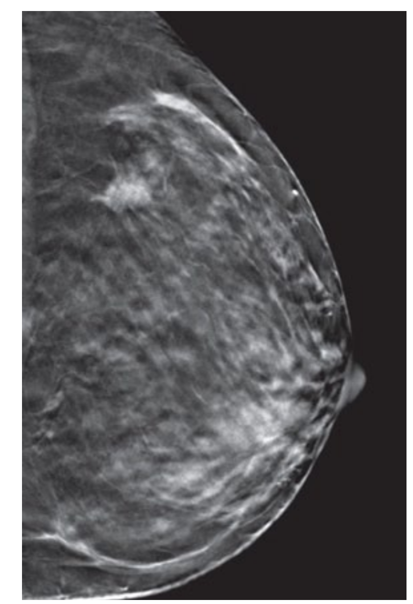
The Contrast Enhanced 2D (CE2D) Imaging provides functional imaging information and highly detailed 2D images for enhanced precision in breast cancer detection. 3D Mammography images may also be combined with CE2D Imaging, creating powerful studies with the functional imaging benefits of contrast and proven advantages of 3D Mammography.



2D Digital Image



CE2D Image showing single foci



Tomosynthesis Slice showing tumor morphology

How Mammograms are Classified?

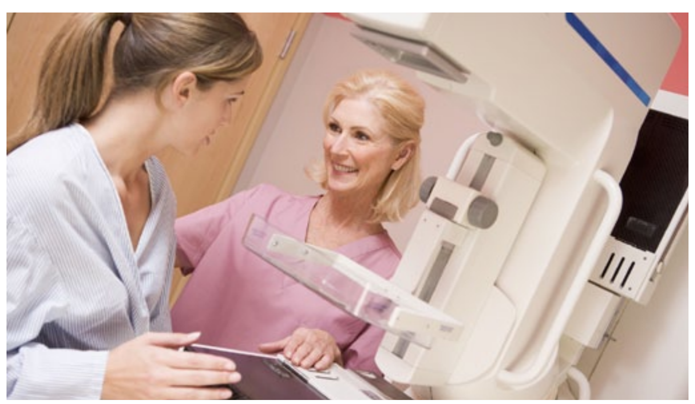
Mammogram results are often expressed in terms of the BI-RADS Assessment Category, often called a "BI-RADS score." The categories range from 0 (Incomplete) to 6 (Known biopsy – proven malignancy). In the United Kingdom, mammograms are scored on a scale from 1 to 5 (1 = normal, 2 = benign, 3 = indeterminate, 4 = suspicious of malignancy, 5 = malignant).
(Liu, Jie; Page, et al. *"Genetic Variants Improve Breast Cancer Risk Prediction on Mammograms". American Medical Informatics Association Symposium (AMIA), 2013).*

Further Studies:

An observational Study led by Stephen L. Rose et al.: *"Population-Based Study shows that 3D Breast Tomosynthesis Mammography Significantly Reduces Recall Rates While Simultaneously Improving Cancer Detection".*
This study compared the outcomes of 2D mammography screening exams that were interpreted prior to the introduction of 3D mammography, with screening exams after the introduction of 3D mammography into the practice.
The Rose study found that the use of 3D mammography resulted in:
- A significant 38% drop in recall rates.
- An 11% drop in biopsy rates.
- A 35% increase in cancer detection rates.
- A 53% increase in invasive cancer detection rates.

A Population-based Screening study Program by Skaane P, Bandos A, et al.: *"Comparison of Digital Mammography Alone and Digital Mammography Plus Tomosynthesis"; Radiology 2013 Jan 7; ref:http://radiology.rsna.org/content/early/2013/01/01/radiol.12121373.full*
concluded that the addition of Tomosynthesis to digital mammography in the screening population resulted in a significant increase in cancer detection rate, particularly for invasive cancers, and a simultaneous significant decrease in false-positive rate. The increase was observed across all breast densities.

	Digital Mammography alone: 1000 women screened	Digital Mammography plus Tomosynthesis: 1000 women screened	Relative Change
False-positive rate	61.1	53.1	↓15%
Cancer Detection Rate (invasive and in-situ cancers)	6.1	8.0	↑27%
Cancer Detection Rate (invasive cancers)	4.4 (56 detected)	6.4 (81 detected)	↑40% (25 additional)



Conclusion

The proper use and selection of Technology, Digital Mammography with Tomosynthesis, High Transmission Cellular Grids, and maybe Contrast Enhanced imaging, will definitely offer radiologists the proper tool to detect cancer as early as possible, reduce false-negatives and reduce patient dose and exam time while increasing resolution and image clarity.