



Past-Present and Projections:
Current Trends in Breast Imaging Detection and Diagnosis

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Breast Specific Gamma Imaging




Imaging Breast-Specific Gamma

The differentiation of malignant and benign tissue.

Nuclear medicine procedure that images the metabolic activity of breast lesions through radiotracer uptake.







Imaging is done using a high-resolution anatomic-specific gamma camera.

Used as a “next step measure” when post-mammogram evaluation is indicated.

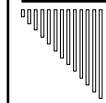
Scintimammography has long shown promise as a diagnostic tool for breast cancer detection however it was limited because it used a standard gamma camera and did not allow for the reliable detection of sub-centimeter lesions or direct correlation to mammograms



- Improves lesion contrast for detection of earlier stage cancers as small as 3 mm
- Locate in breast center for same-day diagnosis
- Mobile system-no installation costs



- Mammography remains the critical first screening measure
- BSGI images metabolic activity which aids in the differentiation of benign and malignant masses
- Metabolic imaging of nuclear medicine is less effected by variations in tissue density
- Offers a vital adjunct to mammography and ultrasound



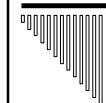
Difficult-to-interpret cases

- Dense breast tissue
- Multiple suspicious lesions
- Palpable lesions not detected with mammography or ultrasound
- Hormone replacement therapy
- Post-surgical or post-therapeutic mass
- Implants
- www.dilon.com



The T-Scan™

Electrical Impedance Scanning System- for Early Detection of Breast Cancer in Young Women



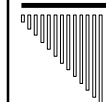
Introduction to Electrical Impedance Scanning (EIS)

- Measures the rate of electrical flow across tissue
- Impedance is dependent on many factors with water content being of major significance
- EIS identifies areas of high current density associated with cancer
- Electrical flow should be homogeneous across normal tissue

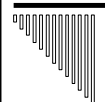


How the T-Scan™ is Performed

- The scan can be performed by either a nurse, medical personnel, technologist or even a doctor
- The patient lies on a table (as she would for an Ultrasound), with her head slightly elevated
- She holds a small cylinder in her hand which introduces a low-level current (2.5 volts) to her body




- A small amount of gel is applied to the probe
- The probe is then placed on the breast
- Nine images of each breast are obtained




What Do EIS Results Mean to the Patient?

- MX detection rate for breast ca in women over 40:
 - ~ 3 ca detected per 1000 MX exams
 - i.e. ~ 1:333 cancers are detected in MX
- Incidence women under 40 (30-39):
 - "average risk" in women 30-40 is ~ 1.5/1000
 - i.e. women ~ 1:666
 - too high for standard MX screening, so is not done




What Do EIS Results Mean to the patient?

- T-Scan:
 - Finds 6.1/1000 in the 30-39 age group
 - NEGATIVE T-Scan = Risk of 1:666
 - POSITIVE T-Scan = Risk of 1:111
 - Now...worth screening




Limitations of T-Scan™

- T-Scan 2000 ED does not localize the lesion
 - It indicates how electrical current flows through the patient's breast tissue
 - Whether or not the electrical flow conducts differently than the rest of the normal population
 - Localization and management will continue to follow the current standard of care



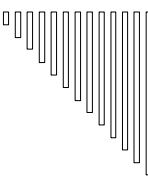
Limitations of T-Scan™

- T-Scan 2000 ED is a high risk tool
 - Results indicate if the patient is at high risk of developing breast cancer, NOT that the patient has cancer now




Contraindications for T-Scan™

- Pregnant
- Breast feeding within last 3 months
- Can not have any electrical implanted device
- Core bx within last 3 months
- FNA within last 30 days
- No reconstructive surgery
 - Implants
 - Reduction



BREAST MRI



Common Uses of MRI for Breast Imaging

- Breast cancer screening
- Diagnosis of breast cancers or abnormalities
- Evaluation of responses to neoadjuvant chemotherapy
- Problem Solving



Screening

Who is at high risk for breast cancer?

- Personal history of breast cancer
- ADH (Atypical Ductal Hyperplasia) ☆
- LCIS (lobular carcinoma in situ) ☆
- History of mediastinal irradiation



Screening

Who is at high risk for breast cancer?

- Patients with positive genetic testing
BRCA 1 or 2 mutation
- Positive axillary mets
w/o mammographic or sonographic evidence of primary breast cancer
- Strong family history of breast and ovarian cancer



Indications for Breast MRI

- Monitor response to neoadjuvant chemotherapy
- Detection of recurrence in post radiation therapy pts
- Work up of axillary metastasis with negative mammo
- Nipple discharge with negative ductography
- Suspected rupture of breast prosthesis/implants
- High risk patients that have gone through genetic counseling for BRCA1 or BRCA2



Genetic Predisposition for Breast Cancer Patients

- 2-5% of all breast cancers are due to inherited susceptibility
 - Lifetime risk for carriers is 60-80%
- >50% are affected by breast cancer before age 50
- Testing and Treating options are available




Why Breast MRI?

- Evaluate abnormalities detected by mammography.
- Screen for cancer in women who have implants or scar tissue that might jeopardize an accurate result from a mammogram.
- Determine the integrity of breast implants.
- Distinguish between scar tissue and recurrent tumors.
- Assess multiple tumor locations.



Why Breast MRI?


- Determine whether cancer detected by mammography or ultrasound has spread further in the breast or the chest wall.
- Determine how much cancer has spread beyond the surgical site after a breast biopsy or lumpectomy.
- Look for multiple tumors prior to breast conservation surgery.
- Assess the effect of chemotherapy.
- Provide additional information on a diseased breast to make treatment decisions.



Contrast or No Contrast?

What are we looking for if we do NOT give contrast?


- Breast Tissue Density
- Cysts (usually benign)
- Enlarged Ducts
- Hematomas
- Leaking or Ruptured Breast Implants



Contrast or No Contrast?

What are we looking for if we give contrast?


- Breast Abnormalities (benign or malignant)
- If Malignant, size & shape of lesion
- Presence of enlarged lymph nodes



What are the benefits vs. the risks?

BENEFITS


- Noninvasive imaging technique that does not involve exposure to radiation
- Because MR imaging does not involve radiation, the procedure could be used to screen women younger than 40 and to increase the number of screenings per year for women at high risk for breast cancer.
- The contrast material used in MRI exams is less likely to produce an allergic reaction than the iodine-based materials used for conventional x-rays and CT
- MRI is growing in popularity in the early diagnosis of breast cancer.
- MRI has been shown to detect small breast lesions that are sometimes missed by mammography.
- MRI enables the detection of abnormalities that might be obscured by bone with other imaging methods.



What are the benefits vs. the risks?


RISKS

- The MRI examination poses almost no risk to the average patient when appropriate safety guidelines are followed.
- If sedation is used there are risks of excessive sedation. The technologist or nurse monitors the patients vital signs to minimize this risk.
- Although the strong magnetic field is not harmful in itself, medical devices that contain metal may malfunction or cause problems during an MRI exam.
- There is a very slight risk of an allergic reaction if contrast material is injected. Such reactions usually are mild and easily controlled by medication. Nephrogenic systemic fibrosis is currently recognized, but rare, complication of MRI believed to be caused by the injection of certain (but not all) MRI contrast material in patients with poor kidney function.



What are the limitations of Breast MRI?

- Size (obesity)
 - Alternative Open MRIs
- Metallic Implants
 - Pacemaker, Stents, Valves, etc
- Pregnancy
 - There is no reason to believe that magnetic resonance imaging harms the fetus, the effects of a strong magnetic field are not well understood. For this reason pregnant women usually are advised not to have an MRI exam unless medically necessary.
- Cost and Time
 - MRI Costs more than other modalities and usually takes longer to perform exams.



What are the limitations of Breast MRI?

- Pain or Anxiety
 - May need sedation
- False Positive Result
 - MRI cannot always distinguish between cancer and benign breast disease (fibroadenomas)

Breast MRI

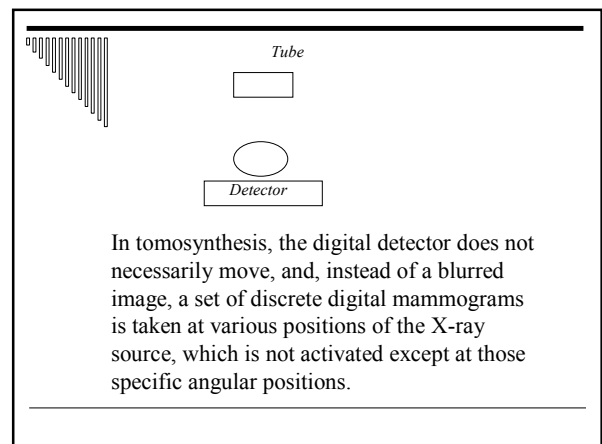
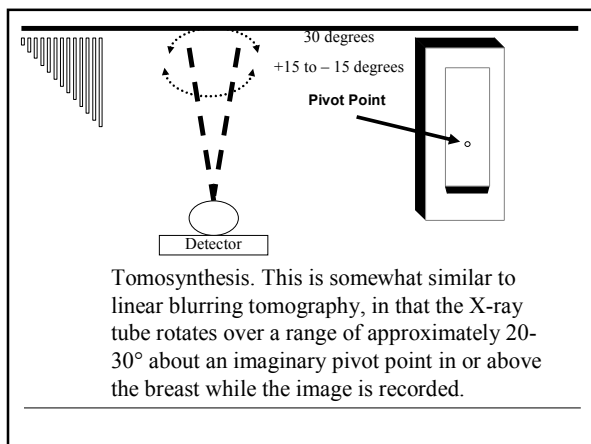
MRI Guided Biopsy


- ### Why do we do MRI Guided Breast Biopsies?
- Lesions are not seen on other imaging modalities
 - Second look ultrasound was negative
 - Patient Requested

- ### Who is involved in a MRI Guided Breast Biopsy?
- **MRI Department**
 - MRI Technologist
 - Radiology Nurse
 - **Imaging Physics Department**
 - MIT Technologist
 - MRI Physicist
 - **Radiologist**
 - **Mammo Technologist**

Tomosynthesis


Digital mammography provides images with improved dynamic range and SNR, as well as the ability to adjust image brightness and contrast after acquisition. Despite these improvements it is limited in the same manner as film/screen due to superimposition in a 2D image.






Digital Tomosynthesis

- Experimental
- Takes multiple x-rays of each breast from many angles
- Scans are used to construct a three-dimensional image of the breast
- Allows doctors to look at cross-sections of the breast
- Would reduce the problem of overlapping tissues
- May improve detection of early-stage breast cancer and reduce the number of unnecessary biopsies
- Currently available for research purposes




Breast Digital Subtraction Angiography


Early Results: Breast DSA




- Vessels of 150 microns or less will be visible - compared to a minimum of greater than 250 microns for the best conventional interventional systems
- Detection of lesions not seen with conventional x-ray imaging may be possible
- Detection of lesions smaller than current conventional x-ray imaging may be possible
- Breast DSA will demonstrate the small vessels feeding a tumor



The breast is compressed slightly (you do not want to cut off blood flow). A "mask" image is taken. Immediately after the exposure 75-100mL of Omipaque 300 is injected in the antecubital vein. A series of 5 post contrast images are then acquired over 7-10 minutes. Post injection images are acquired at 49 kVp (less radiation and better for contrast). The images are then registered to the mask and a subtraction algorithm is applied.



CTLM-Computed Tomography Laser Mammography



CTL Laser breast imaging is part of the field of optical imaging


CTLM images blood flow to the breast to identify tumors

CTLM doesn't use ionizing radiation

CTLM images through implants and dense tissue easily

There is NO breast compression – the breasts hang in the machine in it's natural position

The average scan time is about 10-15 minutes per breast

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- The current CTLM will initially be used in conjunction with x-ray and ultrasound to assist in differentiating malignant from benign lesions and help reduce the great number of invasive biopsies performed which later prove to be negative.



POSITRON EMISSION MAMMOGRAPHY (PEM)



Advantages

- Shows glucose uptake in cancer cells
- FDG – no significant allergic reactions
- Not affected by hormonal modulated dense breast
- Less expensive device
- No claustrophobia
- Good diagnostic capability for DCIS

Disadvantages

- Uses radiation

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PEM Imaging Tool

Reimbursed for:


- Surgical planning - extent of disease
- Suspicion of recurrence
- Equivocal exams
- Neoadjuvant chemotherapy
 - For monitoring response to therapy

** Schilling: High Resolution PEM: Utility in Pre-Surgical Planning for Breast Cancer Patients. SNM Meeting 2008

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Breast Thermography





Based on the theory....

- Angiogenesis, or new blood vessel formation, is necessary to sustain the growth of a tumor. Breast thermography may be the first signal that such a possibility is developing.

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- Breast thermography offers women information that no other procedure can provide. However, breast thermography is not a replacement for or alternative to mammography or any other form of breast imaging. Breast thermography is meant to be used in addition to mammography and other tests or procedures.

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- Breast thermography and mammography are complementary procedures, one test does not replace the other. All thermography reports are meant to identify thermal emissions that suggest potential risk markers only and do not in any way suggest diagnosis and/or treatment.


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- The use of Digital Infrared Imaging is based on the principle that metabolic activity and vascular circulation in both pre-cancerous tissue and the area surrounding a developing breast cancer is almost always higher than in normal breast tissue.

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- In an ever-increasing need for nutrients, cancerous tumors increase circulation to their cells by holding open existing blood vessels, opening dormant vessels, and creating new ones (**neovascularization**).
 - This process frequently results in an increase in regional surface temperatures of the breast.
 - Breast thermography uses ultra-sensitive medical infrared cameras and sophisticated computers to detect, analyze, and produce high-resolution diagnostic images of these temperature variations.



The Procedure

- The patient is left for 15 minutes in order for your body to reach a steady temperature state in equilibrium with the special temperature conditions of the room (19C-23C).
- The patient is positioned in front of the imaging system so that all of the surfaces of the breasts, upper chest, and under arms are imaged.

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- **The images are captured in real-time from an ultra-sensitive medical infrared imaging camera** and sent to a sophisticated computer for storage and analysis (the images are kept on archival media for precision comparison of future images so that the breasts can be monitored over time). Sophisticated computer programs allow the doctor to isolate temperature differentials, perform vascular analyses, dynamic thermal subtraction studies, and more.



- **After the images have been analyzed, they are graded** using a strict standardized reading protocol. Each breast's image is placed into one of five thermobiological (TH) categories:
- **TH 1** – Normal uniform non-vascular
 - **TH 2** – Normal uniform vascular
 - **TH 3** – Equivocal (questionable)
 - **TH 4** – Abnormal
 - **TH 5** – Severely abnormal