A Guide to Breast Imaging: The Latest Technology for Screening and Detecting Breast Cancer

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What is breast imaging?

- Any modality that can image the breast: mammography, ultrasound, MRI, molecular breast imaging (FDA approved)
- Breast imagers are radiologists specializing in the diagnosis and follow up of breast diseases
Definitions

- Screening – asymptomatic; elective procedure
- Diagnostic – symptom: lump, focal pain, swelling, or nipple discharge
- OR an abnormal screening study

- For diagnostic studies the clinical question must be addressed.
- Patients are scheduled as quickly as possible.
- Patient gets results on same day.
Normal breast anatomy and function

- Glands that produce milk (lobules)
- Ducts that convey milk to nipple
- Supporting tissues
- Fat
A Good Screening Test:

- An acceptable test
- Minimal risk, reasonable cost
- Test is accurate
- Test detects early disease
- Evidence that early detection and treatment improve outcomes
- **Mammography**
ACS Screening Guidelines

- General population - annual mammogram beginning at age 40

- Accelerated screening based on family or personal history of breast cancer or high risk markers

- Annual MRI in addition to mammography for those with a lifetime risk of over 20%
Risk of breast cancer

- Lifetime risk of breast cancer for general population is 1/8 or 12-13%.

- Patients with BRCA gene mutations have a very high risk 50-85%.

- BRCA gene mutations are most common in patients of Ashkenazi Jewish descent but can occur in all ethnic backgrounds.

- You can estimate your personal lifetime risk of breast cancer by finding a personal breast cancer risk estimator on the web or having your doctor calculate this for you based on your family history.

Mammography disadvantages

- Overlap of tissue
- Sensitivity of cancer detection dependent on breast density
- Radiation
- False positives
- Compression needed to produce good quality image and to decrease radiation
DMIST (digital mammography imaging screening trial)

- For the general population of women, the study showed no difference between digital and film mammography in detecting breast cancer.

- Digital mammography detected up to 28% more cancers than standard film mammography in:
  1) women under age 50
  2) premenopausal and perimenopausal women
  3) women with dense breasts

- In the DMIST trial, 65% of women were within at least one of these groups.
What is Breast Tomosynthesis?

- A method of imaging the breast in three dimensions (3D)
- Image slices are 1 mm thick
- Image slices high resolution: like mammograms
- X-ray tube moves in an arc across the breast
- Series of low dose images are acquired at different angles
- Total dose similar to single view breast exam
Mammography Limitations

- As many as 20% of breast cancers will be missed by mammography.
- Approximately 10% of women are recalled for additional workup.
- A significant portion of these 10% prove to have no abnormality, resulting in unnecessary anxiety and cost: (false positives).
Tomosynthesis was FDA approved because

Data from thousands of cases and hundreds of readers showed it…

- Detected more cancers
- Called back fewer false positives
Ultrasound is used to assess:

- Palpable lumps
- Mammographic abnormalities
- Screening - as an adjunct to mammography
- Biopsy planning
- Assessment of axillary lymph nodes
Ultrasound advantages

- Uses sound waves: No radiation!
- Relatively inexpensive
- No compression, no discomfort
Mammographic Sensitivity

- 98% in women $\geq 50$ with fatty breasts
- 30\%-69% sensitivity in women with dense breasts, particularly low if $< 50$ or at increased risk

Kerlikowske et al JAMA 1996;276:33-38
Kolb et al Radiology 2002;225:165-175
Mandelson et al JNCI 2000;92:1081-1087
Breast Density

- Breast density contributes to greater difficulty in detecting cancer on mammography

- Breast density is an independent risk factor for cancer

Connecticut law since October 2009 requires women be informed of their breast density and be offered supplementary screening if dense.

Illinois requires insurers to cover ultrasound screening if breasts are heterogeneously dense or extremely dense.

NY, Texas, California have passed legislation and many others are working on it.

Federal legislation for density notification is being considered.

U-systems sponsoring a large multi-institution study to determine screening benefit.
Despite legislation…

- Lack of evidence (mortality benefit) that supplementary screening is beneficial.

- Breast density assessment by radiologists is still subjective!
Screening US

- Detects some cancers not seen on mammography
- Especially in high risk and dense breasts
- No long term studies on mortality to show benefit
- Very operator dependent
- Time consuming
- Many false positives

Whole breast ultrasound

- Remove operator dependence
- Improve reliability of exams
- Facilitate measurements for follow up exams
- Correlation with mammography, MRI
- Quick whole breast scanning
Breast MRI

- Anatomical detail and functional/physiologic information
- Cancers require blood supply in order to grow.
- Growing cancers recruit and develop new blood vessels in order to supply them.
- These rapidly forming blood vessels are defective/immature.
- When you give a dye (Gadolinium) that circulates through blood vessels, it will leak out of defective ones and appear on the image as bright areas.
MRI Indications

- High Risk Screen
- Staging a known breast cancer
- Assess Response to chemotherapy
- Assess Implant Integrity
- Carcinoma of unknown primary
- Problem Solving
MRI advantages / disadvantages

- Not affected by breast density
- No radiation
- Gadolinium is taken up by abnormal tumor blood vessels
- High sensitivity for invasive breast cancer and for DCIS (higher than mammography)
- Quality of exam and interpretation currently variable. Biopsy capability not universally available. (compare with mammography in early 90’s)
- ACR accreditation for breast MRI is here and will be mandatory beginning January 2012.
- Very costly; follow ups may not be covered
- Claustrophobia, discomfort
High risk screening with MRI:

Who needs it and who doesn’t?
Recommend Annual MRI Screening (Based on Evidence*)

- BRCA mutation
- First-degree relative of BRCA carrier, but untested
- Lifetime risk 20–25% or greater, as defined by BRCAPRO or other models that are largely dependent on family history

*Evidence from nonrandomized screening trials and observational studies.*

American Cancer Society Guidelines for Breast Screening with MRI as an Adjunct to Mammography
Saslow et al; CA Cancer J Clin 2007; 57:75-89
Recommend Annual MRI Screening (Based on Expert Consensus Opinion)

- Radiation to chest between age 10 and 30 years
- Li-Fraumeni syndrome and first-degree relatives
- Cowden and Bannayan-Riley-Ruvalcaba syndromes and first-degree relatives
1380 patients who were survivors of Hodgkin’s between ages 10 and 16

- Risk was 75 times! the risk in the general population.
- The estimated actuarial cumulative probability of breast cancer was 35 percent at 40 years of age.
Insufficient Evidence to Recommend For or Against MRI Screening

- Lifetime risk 15–20%, as defined by BRCAPRO or other models that are largely dependent on family history
- Lobular carcinoma in situ (LCIS) or atypical lobular hyperplasia (ALH)
- Atypical ductal hyperplasia (ADH)
- Heterogeneously or extremely dense breasts on mammography
- Women with a personal history of breast cancer, including ductal carcinoma in situ (DCIS)
Recommend Against MRI Screening (Based on Expert Consensus Opinion)

- Women at <15% lifetime risk
If you’re having annual MRI why do you still need a mammogram?

All studies have shown some cases of cancers which were missed by MRI and were detected with mammography (mostly low and intermediate grade DCIS with calcifications).
MRI screening: advantages and disadvantages

- Extremely sensitive for breast cancer
- Variability in background parenchymal enhancement.
- Hormonal issues. Ideal scanning is between days 7-14 of cycle.
- Recall rate goes down in screeners having had one or more prior exams.
- Expensive and time consuming.

- No data on mortality
### Molecular breast imaging

- Physiologic (vs. anatomic) imaging.
- Metabolically active tissues will take up Tc99m Sestamibi. (Same isotope used for cardiac scanning.)
- Uses detectors similar to mammography.
- No compression. Breast is immobilized.
- Exam takes 40 minutes (10 minutes per breast)
- Current FDA approved techniques use 20 mCi.
- Ongoing research on use of lower doses.

- Current vendors: Dilon (BSGI) and Gamma Medica (LumaGEM MBI)
MBI advantages

- Not impaired by breast density or presence of implants or free silicone.
- High sensitivity and relatively good specificity.
- Well tolerated.
- Fewer false positives (vs. ultrasound and MRI).
- Relatively less expensive (vs. MRI).
Radiation from MBI

- Higher radiation dose to whole body (6.2 to 9.4 mSv = 2 to 3 years of natural background radiation exposure).
- Compared with mammography (0.44 to 0.56 mSv, = 2 months of natural background radiation.)
- The organs receiving the highest doses and therefore at greatest risk for cancer induction from radionuclide administration are the colon, lungs, and bladder. Not breast!
- Potential impact for high risk women having frequent screening.
Dedicated Dual-Head Gamma Imaging for Breast Cancer Screening in Women with Mammographically Dense Breasts

- 936 women with dense breasts and normal screening mammograms enrolled and followed for 12 months

- Results: 11 cancers

- Diagnostic yield:
  - mammo: 3.2/1000
  - MBI: 9.6/1000
  - combined MBI/mammo: 10.7/1000

- Significant increased detection rate but at increased dose

Rhodes et al; Radiology January 2011 258:106-118
Recommended references


- Information on breast density and supplemental screening: [http://www.areyoudense.org/](http://www.areyoudense.org/)