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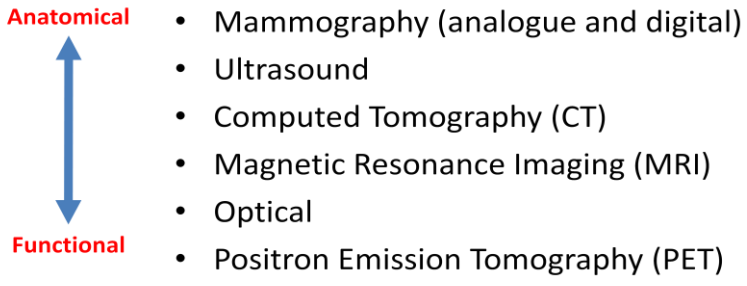
New Approaches to Breast Imaging

A mini-symposium at the 2009 San Antonio Breast Cancer Symposium presented five different views of current uses of various modes of imaging; the specific presentations are listed at the end of this discussion. Imaging is useful from early detection to diagnosis and treatment planning, for monitoring treatment of breast cancer, as well as for research purposes. The following table provides a summary of each of these uses, and the desired characteristics of an imaging modality.

Type	Used To	Necessary Characteristics	Optimal Characteristics
Detection/ Screening	Detect new cancer in healthy individuals	•Low cost •Non-invasive •Minimal harms •Low error rate	•Rapid results
Diagnosis/ Staging	Classify and assist in planning treatment of individuals with suspected or confirmed breast cancer	• Low error rate • Moderate invasiveness • Few harms	• Distinguish between indolent and lethal cancer • Predict most effective treatment
Monitoring	Assess effectiveness of treatment; Identify recurrences and/or metastases	• Assess shrinkage • Distinguish shrinkage from necrosis • Identify metastases in all areas of body	• Predict most effective additional treatment
Research	Develop better imaging methods; Increase understanding of the natural functioning of normal and cancerous tissues	• Technically feasible • Expand upon capability of standard techniques	• More accurate and/or less harmful than existing techniques • Economical viable

At least six types of imaging are in current use. These are listed below along a continuum of modalities most useful in assessing anatomical (i.e., physical features) versus functional (i.e., biological functioning) aspects of the breast.



While the imaging modalities most commonly used in the clinic are primarily anatomical, much research focuses on functional modalities. In these methods special imaging agents are injected into the to-be-imaged tissue; this allows their function to be studied. These imaging agents tag molecules that hone in on specific biomarkers of interest with molecules that can be visualized (e.g., fluorescing particles). In this way tissue that contains the biomarker of interest can be distinguished from normal tissue. In essence, this technique allows tracking biomarkers in-vivo (in the body). Currently biomarkers are tracked in-vitro (outside of the body), which requires using tissue obtained from biopsies. However, biopsies are invasive and not always possible when cancer metastasizes. Thus, the promise of functional imaging is the promise of using biomarkers to better understand, detect and treat cancer without the need for biopsies.

References

1. **Overview of modalities and PET imaging**
   David Mankoff, MD, PhD
   University of Washington
   Seattle, WA
2. **Breast ultrasound**
   Wendie A. Berg, MD, PhD, FACR
   Johns Hopkins Green Spring
   Lutherville, MD
3. **Breast MRI**
   Mitchell D. Schnall, MD, PhD
   University of Pennsylvania
   Philadelphia, PA
4. **Dynamic molecular imaging of signal transduction pathways in vivo**
   David R. Piwnica-Worms, MD, PhD
   Washington University
   St. Louis, MO

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Is there a Role for Magnetic Resonance Imaging (MRI) in Breast Cancer Diagnosis?

Breast Cancer is detected through mammography and/or physical examination (PE) and confirmed through biopsy. During the diagnostic workup, ultrasound (US) and/or MRI are often used to:

1. identify the full extent of disease in the ipsilateral breast (i.e., the breast in which cancer was first detected);
2. identify breast cancer in the bilateral breast (i.e., opposite breast);
3. identify a primary tumor when cancer is first discovered in the axilla or elsewhere in the body; or
4. establish baseline and response when neo-adjuvant therapy (i.e., systemic therapy given prior to surgery) is used.

One of the plenary sessions (Morrow, M. *The Role for Magnetic Resonance Imaging in the Breast Cancer Patient)* at the 2009 San Antonio Breast Cancer Symposium presented a plethora of data on the appropriateness of these uses. Also, a general session paper (Drew, P.J, et al *The UK NIHR Multicentre Randomised COMICDE Trial of MRI Planning for Breast Conserving Treatment for Breast Cancer*) reported recent data relevant to this topic.

The question discussed during these sessions was to what extent these uses of MRI during diagnosis leads to better outcomes. Evidence of better outcomes would include:

1. fewer conversions from breast conservation to mastectomy that require second operations;
2. fewer second surgeries to re-excise margins;
3. fewer later surgeries to the contralateral breast;
4. few local recurrences;
5. better overall survival.

Compelling evidence from meta-analyses, as well as large national European trials, indicated that adding MRI to mammograms, US, and PE following a positive biopsy:

1. identified significantly more disease in both the ispsilteral and bilateral breasts;

2. resulted in more mastectomies; but
3. did not result in fewer second surgeries. Further, the addition of the MRI added several weeks delay between diagnosis and surgery.

In addition, the British study attempted to assess the economic consequences of adding MRI to a breast cancer diagnostic work-up, but found that any economic effect was overwhelmed by the large cost associated with breast cancer treatment.

These results seem to be paradoxical -- MRI leads to the surgical removal of more cancer, but not to better outcomes. The paradox can be resolved if: 1) much of the additionally identified and removed cancer would have regressed or been non-problematic regardless of treatment; and/or 2) systemic treatment, which is widely used after breast cancer surgery, would have adequately treated the additionally cancers, regardless of whether or not they had been identified and removed.

Although these presentations appear to dispel the myth that routine MRI following breast cancer diagnosis improves treatment planning, several appropriate uses of MRI in the diagnostic arena were mentioned. These include:

1. known or suspected BRCA 1 or 2 mutations where mastectomy is not planned;
2. presentation of axillary adenopathy (i.e., cancer in the underarm lymph nodes) when no tumor can otherwise be detected in the breast;
3. when there is conflicting evidence about the extent of disease from mammogram, US, and PE.

Additionally, there may be a role for MRI in screening very high risk women, as well as in monitoring the performance of neo-adjuvant therapies.

References:

Morrow, M. *The Role for Magnetic Resonance Imaging in the Breast Cancer Patient.*

Drew, P.J, et al *The UK NIHR Multicentre Randomised COMICDE Trial of MRI Planning for Breast Conserving Treatment for Breast Cancer*.

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