Controversies in Breast MRI

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American Cancer Society Guidelines for Breast Screening with MRI as and Adjunct to Mammography

CA Cancer J Clin 2007

- ACS recommends annual MRI screening for women with >20% lifetime risk of breast cancer
  - BRCA gene mutation carriers
  - First-degree relative of BRCA carrier, but untested
  - Lifetime risk: >20%, as defined by BRCAPRO or other models (eg. Tyrer- Cuzick) that are largely dependent on family history

Estimated to affect 1.7 million women
Clinical Role Controversies

- Does breast MRI show invasive cancers not detected with mammography?
- Does MRI miss a lot of DCIS?
- Is breast cancer screening with MRI cost effective in high risk women?
- Does pre-op breast MRI increase mastectomy rate, delay surgery, and/or reduce reoperation rate?
- Is breast MRI useful in patients with BI-RADS 3-5 microcalcifications or in the evaluation of inconclusive mammographic findings?
- How often should patients with breast implants undergo MRI to evaluate implant status?
- How does breast MRI compare with BSGI and PEM?
Technique Controversies

- What is optimal timing and number of post-contrast scans?
- Is breast MRI improved with high relaxivity GBCA?
- Is DWI useful in the breast, and can it really replace CE-MRI?
- Does MR Spectroscopy have a role and can it be performed in routine clinical practice?
Interpretation Controversies

- Is there standardization of interpretations?
- How good is BI-RADS for predicting malignancy in masses vs nonmasslike enhancement?
- Is CAD necessary for interpretation of breast MRI?
- What is frequency of malignancy in probably benign lesions at CE-breast MRI?
- When to do follow-up for discordant MRI suspicious biopsy negative lesions and for concordant, histologically benign lesions?
Is Breast MRI Beneficial?

Does breast MRI detect DCIS?

- Reported sensitivity of CE-MRI for detection of DCIS is 77-96%
  - 48% of high grade DCIS were visible on MR but missed on mammography
  - Approx 20% of low grade DCIS do not enhance

DCIS-containing ducts are fed by diffusion from extraductal vessels

- Enhance due to increase permeability of the basement membrane (secondary to increased protease activity induced by intraductal cancers)
- Hypoxia and calcification are not required for enhancement
- MRI enhancement may be a biomarker that predicts the natural behavior of DCIS (i.e. progression to invasive cancer)

Ductal Carcinoma in Situ: X-ray Fluorescence Microscopy and Dynamic Contrast-enhanced MR Imaging Reveals Gadolinium Uptake within Neoplastic Mammary Ducts in a Murine Model

**Purpose:**
To evaluate dynamic contrast material-enhanced (DCE) magnetic resonance (MR) imaging with X-ray fluorescence microscopy (XFM) of mammary gland tissue samples from mice to identify the spatial distribution of gadolinium after intravenous injection.

**Materials and Methodology:**
- C57BL/6J transgenic mice (n = 23) were studied with intraductal surveillance and x-ray fluorescence microscopy.
- Twelve mice underwent DCE MR imaging after injection of gadolinium, and gadolinium concentration-time curves were fit to a two-compartment pharmacokinetic model with the following parameters: transfer constant (Ktrans) and volume of extracellular extracellular space per unit volume of tissue (k2).
- Eleven mice received gadolinium before XFM. These mice were sacrificed 2 minutes after injection, and frozen slices containing ducts distanced from mammary ductal carcinoma in situ (DCIS) were analyzed.

**Results:**
Ducts containing DCIS were unambiguously identified on MR images. DCE MR imaging revealed gadolinium uptake along the length of ducts with DCIS, with an average Ktrans of 0.21 min⁻¹ ± 0.14 (standard deviation) and an average k2 of 0.40 ± 0.16. XFM revealed gadolinium uptake inside ducts with DCIS, with an average concentration of 0.47 mmol/L ± 0.16. The corresponding value for DCE MR imaging was 0.30 mmol/L ± 0.13.

**Conclusions:**
These results provide insight into the physiologic basis of contrast enhancement of DCIS lesions on DCE MR images: Gadolinium penetrates and collects inside neoplastic ducts.

* RINA, 2009

Supplemental material: [http://radiology.rsna.org/content/suppl/2009/06/23/20082605.DCIF](http://radiology.rsna.org/content/suppl/2009/06/23/20082605.DCIF)
Is Breast MRI Beneficial?

Does breast MRI detect more invasive breast cancers than mammography?

- After 3 years’ screening with mammography and US, adding MRI increased the cancer detection rate among women at elevated risk of breast cancer
  - 463 patients
  - 16 diagnosed with breast cancer (88% seen with MRI)
    - 5 (31%) DCIS
    - 11 (69%) invasive
  - 8 (50%) detected only with MRI
    - 7 of these were invasive (6/6 staged were node neg)
  - 11/52 recommended for bx based on MRI had cancer
    - PPV 21%

ACRIN 6659
Berg WA, et al. RSNA 2009
Is Breast MRI Beneficial?

Does breast MRI detect more invasive breast cancers than mammography?

- After 5 years’ screening of women with > 20 risk breast cancer, MRI was more effective in detecting disease than either half-yearly US and/or annual digital mammography
  - 687 patients (German multicenter study)
  - 27 diagnosed with breast cancer (93% with MRI, 37% with US, and 33% with mammo))
    - 11 (41%) DCIS
    - 16 (59%) invasive
    - 11% node positive
  - Cancer yield with MRI alone was not significantly improved by adding mammography
Is Breast MRI Beneficial?

Does breast MRI screening reduce mortality?

- Annual screening with combined mammography and MRI improves life expectancy and decreases breast cancer mortality for *BRCA1* mutation carriers
- Trade-off is high rate of false-positive results and subsequent biopsies for benign disease

Is Breast MRI Beneficial?

Is screening breast MRI cost effective?

- Breast MR screening is more cost-effective for *BRCA1* than *BRCA2* mutation carriers, and cost effectiveness varies greatly with age
  Plevritis SK, et al. *JAMA* 2006

- Breast MR screening is cost effective for *BRCA1* & *BRCA2* mutation carriers

- Breast MR screening is cost effective for *BRCA1* & *BRCA2* mutation carriers by current standards, and it may also be cost-effective in other high risk groups
  Taneja C, et al. *JACR* 2009
"I believe that mammography is going to be replaced by MRI as the standard for breast cancer screening, not only in high risk women but increasingly in those at average risk.”

Ferris M. Hall, MD
Reasons Women at Elevated Risk of Breast Cancer Refuse Breast MR Imaging Screening: ACRIN 6666

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Purpose:
To determine reasons for nonparticipation in a trial of supplemental screening with magnetic resonance (MR) imaging after mammography and ultrasonography (US).

Materials and Methods:
Women (n = 2809) at elevated risk of breast cancer were enrolled in the American College of Radiology Imaging Network 6666 US Screening Protocol at 21 institutions. Fourteen institutions met technical and experience requirements for this institutional review board-approved, HIPAA-compliant substudy of supplemental screening with MR imaging. Those women who had completed 0-, 12-, and 24-month screenings with mammography combined with US were considered for a single contrast material-enhanced MR examination within 8 weeks after completing the 24-month mammography-US screening. A total of 1593 women had complete MR substudy registration data: 378 of them were ineligible for the study, and 1215 had analyzable data. Reasons for nonparticipation were

Conclusion:
Of 1215 women with elevated breast cancer risk who could, according to protocol guidelines, undergo breast MR imaging, only 57.9% agreed to participate.
Presurgical Breast MRI

- Dense breasts
- BRCA gene mutation carriers
- Other patients with high risk
- Mammographically occult cancer
- Suspect chest wall involvement
- Difficult histology (e.g., invasive lobular carcinoma)
- Candidates for neoadjuvant chemotherapy
Is Breast MRI Beneficial?

Does breast MRI improve outcomes for patients with breast cancer?

- “The routine use of MRI in (breast) cancer patients requires some evidence of clinical benefit. To date, this data does not exist.”
  
  Monica Morrow, MD (Surgeon)
  Memorial Sloan-Kettering Cancer Center

- Breast MRI may delay surgical treatment, increases mastectomy rate, and does not improve surgical margin status

  University Pennsylvania
  Hull York Medical School (England)
  Fox Chase Medical Center
  Brooke Army Medical Center
False-positive findings on MRI have the potential to complicate rather than improve preoperative assessment for women with newly diagnosed breast cancer and may lead to wider resection than necessary.

The current body of knowledge indicates that while MRI has substantial detection yield for additional disease within the affected breast …, identifying these additional (otherwise occult) cancer foci does not lead to better preoperative planning and surgical treatment.