МРТ МОЛОЧНЫХ ЖЕЛЕЗ: КЛИНИЧЕСКИЕ ПОКАЗАНИЯ

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BREAST MRI: CLINICAL INDICATIONS

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Breast cancer facts

- Second in incidence only to non-melanoma skin cancer
- Death rate second only to lung cancer
- 1 in 8 women (12%) risk
- 85% of breast cancer in women with no FH
- Risk doubles if mom, sister or daughter with breast cancer
- 5-10% of breast cancers linked to BRCA1 and BRCA2
  - 80% chance of developing breast cancer

Breast cancer 2011 statistics

- 230, 480 new cases of invasive breast cancer
- 57, 650 new cases of non-invasive breast cancer
- 2, 140 new male breast cancer cases
- 2.75 million women with history of breast cancer

"Pros"

- Studies have documented INCREASED CANCER DETECTION in high risk women with MR imaging compared to mammography and breast ultrasound alone
- Feasibility proven in academic and private practice environments
  - Availability of MR-guided biopsy
  - Acceptable PPV of biopsies recommended
  - National reimbursement for high risk screening with Breast Mri (National BCBS 12.2003)

"Cons"

- As of yet, no proven impact on mortality
- Costly
- False positives may lead to unnecessary interventional procedures
- No consensus on best "MRI screening protocol"

Current indications - Breast MRI

- Pre-operative evaluation of known BC
  - Staging primary (index) lesion
  - Multifocal, multi-centric or bilateral breast cancer in known BC patient
- Tumor size/extent - neoadjuvant chemotherapy
- Residual tumor after excision with + margins
- Tumor recurrence after surgery and/or radiation

Current indications - Breast MRI

- Breast implant integrity
- Problem-solving for equivocal findings
- Screening for very high risk women (20-25% risk of BC)
- Women with + axillary nodes and negative mammogram and/or US
- APUD (Adenocarcinoma primary unknown disease)

Technical requirements

- High field strength magnet (1.5T or >)
- Gadolinium-DTPA injection
- Dedicated breast imaging coils
- Adequate fat saturation techniques
- High resolution 3D gradient echo pulse sequences
  - Bilateral coverage
  - In-plane resolution < 1mm
  - Slice thicknesses < 3mm
- Dynamic imaging with satisfactory temporal resolution
  - 1-2 minutes

Preoperative staging-known BC

- Staging based on-
  - Extent of local/regional disease in breast and axilla
  - Has predictive value regarding patient's prognosis
  - May help decide treatment options
- Breast MRI combined with mammo and CBE has sensitivity of 99% for pre-op evaluation
  - CBE – 50%
  - Mammography – 60%
  - US – 83%

Preoperative staging-known BC

- Breast MRI most appropriate for:
  - Dense breast tissue
    - Mammography sensitivity decreases in proportion to increases in breast density
  - Invasive lobular carcinoma
    - Mammo sensitivity: 34 - 81%
    - MRI sensitivity: 93 - 96%
  - Extensive ductal carcinoma in situ (DCIS)
  - Patients who will undergo neoadjuvant chemotherapy

Preoperative staging-known BC

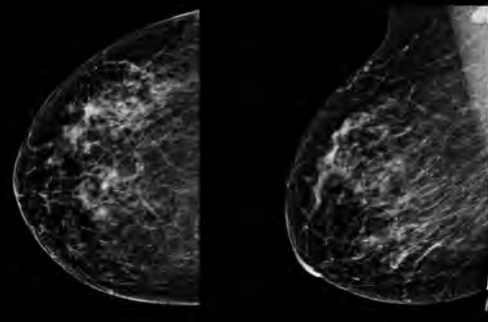
- Ipsilateral additional foci in 10-27% of patients
- Contralateral synchronous tumor
  - 3% of invasive ductal carcinoma (IDC)
  - 6% in invasive lobular carcinoma (ILC)
- Benefits of pre-operative breast MRI:
  - Decreasing number of surgeries required to obtain negative surgical margins
  - Decreased BC recurrence rates
  - Improving long term survival

Breast MRI evaluation Newly diagnosed BC**

- 199 patients with new BC dx
- Preoperative Breast MRI
- MRI detected new lesions in 74 pts (37%)
- 54 lesions in 38 patients (19%) malignant
  - 41 (76%) invasive
  - PPV of biopsy recommendation was 34%
- Information would have altered surgical management in 26 pts (13%)
  - Mastectomy or wider excision

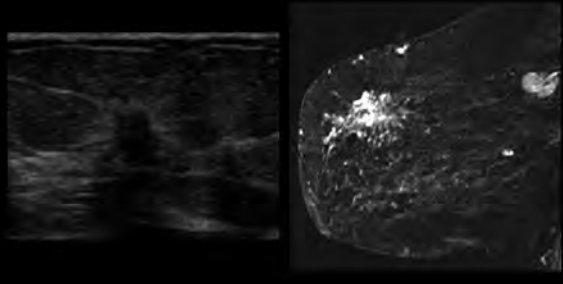
**Schell et al: AJR 2009;192: 1438-1444

Invasive lobular carcinoma



Argus et al. Applied Rad 39, Oct 2010

Invasive lobular carcinoma



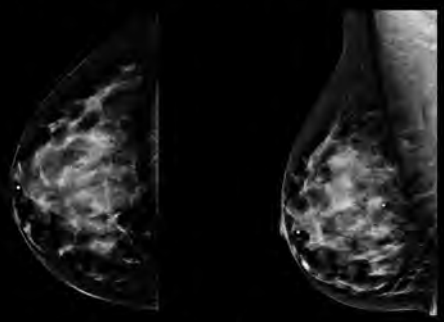
Argus et al. Applied Rad 39, Oct 2010

Multifocal disease

85 yo, small index lesion
Larger enhancing area
Bigger excision

Schell et al: AJR 2009:192

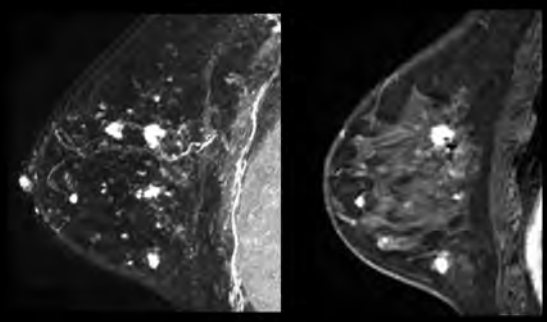
Multicentric invasive ductal cancer



Dense breasts and no abnormality

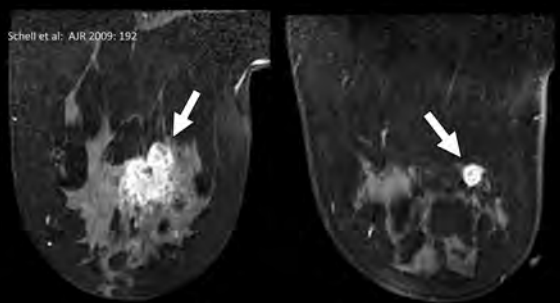
Argus et al. Applied Rad 39, Oct 2010

Multicentric invasive ductal cancer



Argus et al. Applied Rad 39, Oct 2010

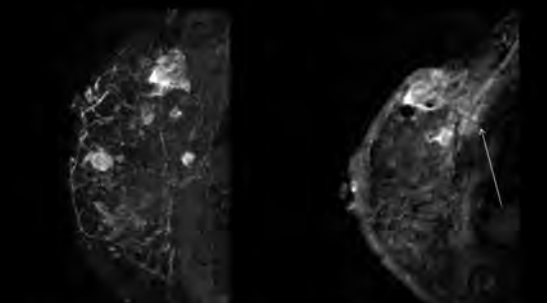
Multicentric disease = Mastectomy



42 yo index lesion left breast
2.5 cm IDC 12 o'clock

Left lower inner quadrant
2cd look US, Bx - IDC

Pectoralis muscle invasion



Sagittal subtraction MIP – first post contrast

Sagittal T1W post contrast subtraction

Argus et al. Applied Rad 39, Oct 2010

MRI findings in contralateral breast Recently Dx BC**

- Retrospective evaluation of 1, 336 consecutive breast MRI exams over 2 yr period
- 223 of asymptomatic, mammo neg contralateral breast
- BC dx within 6 months of MRI exam

**Liberman et al: AJR 2003;180:333-341
Memorial Sloan Kettering

MRI findings in contralateral breast Recently Dx BC**

- Contralateral Bx recommended in 72 (32%) of 223 women and performed in 61
- Clinical and mammo occult ca in 12/61 (20%)
  - 6/12 (50%) DCIS
  - 6/12 (50%) infiltrating cancer
  - Median tumor size 0.5 cm
- Conclusion:
  - MRI of contralateral breast
    - Bx recommendation in 32% of cases
    - Cancer diagnosed in 20%

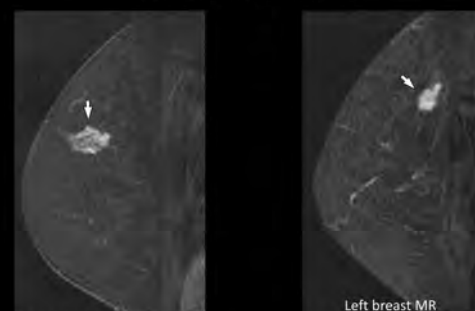
**Liberman et al: AJR 2003;180:333-341
Memorial Sloan Kettering

MRI findings in contralateral breast Recently Dx BC**

- Prospective study of 969 women
- 121 had Bx rec from MRI (13.9%)
- 33 contralateral tumors within 365 days (24.8%)
- Sensitivity 91%, Specificity 88%
- Negative predictive value = 99%
- False + rate of 10.9%
- Low risk of detecting B9 disease on Bx (9.4%)

Lehman et al: N Engl J Med 2007; 356:1295-1303

Known BC Contralateral BC

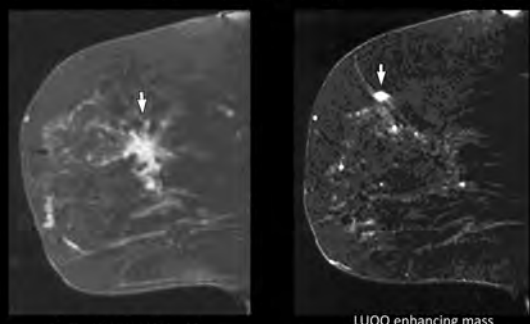


61 yo with right breast cancer

Liberman et al: AJR 2003;180:333-341

Left breast MR
Mammo neg
MRI NL = IDC and ILC

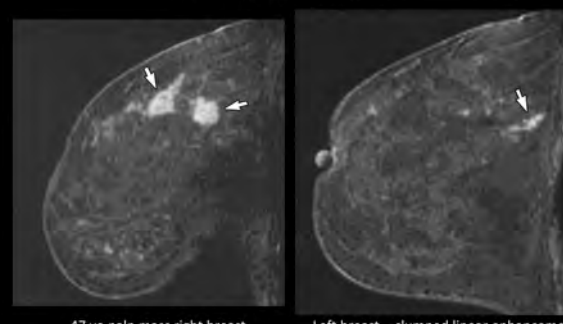
Known BC
Contralateral BC



66 yo palp mass Bx = ILC
Liberman et al: AJR 2003;180:333-341

LUOQ enhancing mass
MRI NL = DCIS

Known BC
Contralateral BC

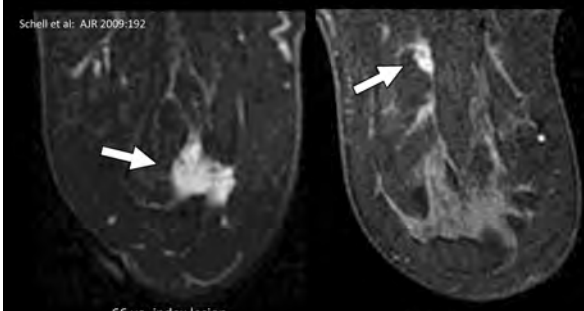


47 yo palp mass right breast
Bx = IDC and DCIS

Left breast – clumped linear enhancement
MRI NL = DCIS

Known BC
Contralateral BC

Schell et al: AJR 2009:192



66 yo, index lesion
Left breast – 2.5 cm IDC

Right breast
2cd look US - ILC

Personal Hx of BC
Screening breast MRI

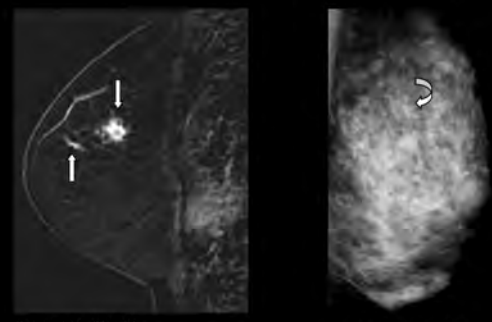
- Pro: Morris et al: AJR 2003;181: 619
  - PPV of Bx recommendation = 32%
  - Increased to 50% with personal hx of BC
- Con: Gorechlad et al: Ann Surg Oncol 2008;15:1703-1709
  - Retrospective study of 476 primary tumor resections-to screen 2570 MRI's would have been done
  - Overall recurrence rate of 4%, ipsilateral recurrences in 1.7% with mean diameter of lesion 1.6 cm
  - Contralateral cancer in 2.3% with mean diameter of 0.8 cm
  - All recurrences invasive
  - 5 cases of DCIS (29%)
  - "Annual screening MRI would have incurred significant cost and would have been unlikely to improve overall survival"

Breast MRI screening
Personal Hx of BC**

- Retrospective review of 1, 699 breast MR exams from 1999-2001
- 144 women with prior hx and no FH of BC
- 44/144 (31%) had Bx based on MR exam
- 17 with malignancy, 10 diagnosed by MRI only!
  - 12 invasive, 5 DCIS and 10 with minimal BC (DCIS or node neg cancer < 1cm in size)
- Screening breast MRI
  - Additional 12% with breast cancer
  - PPV of 39%

** Brennan et al: AJR 2010;195:510-516
Memorial Sloan Kettering

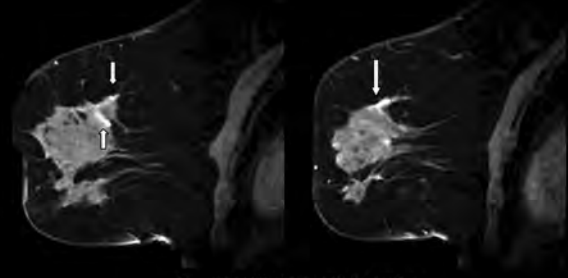
60 yo, h/o IDC 13 years ago



Brennan et al: 2010: 195
Memorial Sloan Kettering

Bx = IDC and DCIS

57 yo right mastectomy - ILC



Screening MRI, Mammogram negative,
Linear enhancement – MRI Bx = ILC and LCIS

Neoadjuvant chemotherapy

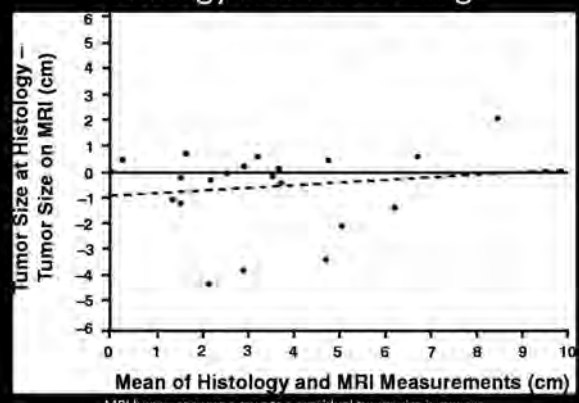
- Increasingly administered preoperatively for locally advanced BC
- Accurate assessment of tumor response to chemo and maximum size of tumor after Rx important predictors of local recurrence
- MRI better than CE and other imaging tests in estimating residual cancer

Neoadjuvant chemotherapy**

- Duke study of 21 patients pre and post
- MRI accurately showed final tumor size:
  - Within 1 cm in 12 (57%)
  - Underestimation > 1 cm in 2 (10%)
  - Overestimation > 1 cm in 7 (33%)
- MRI showed correlation coefficient of 0.75 with histology
- Better than PE

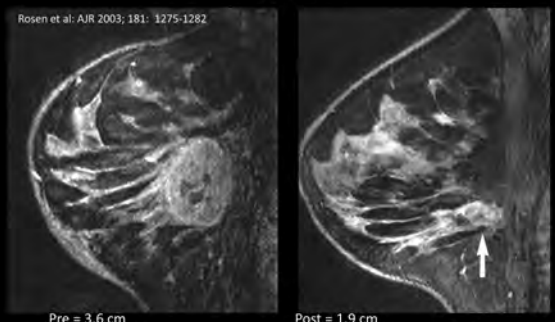
**Rosen et al: AJR 2003; 181: 1275-1282

Histology and MR findings



MRI becomes more accurate as residual tumor size increases

Overestimation 35 yo IDC

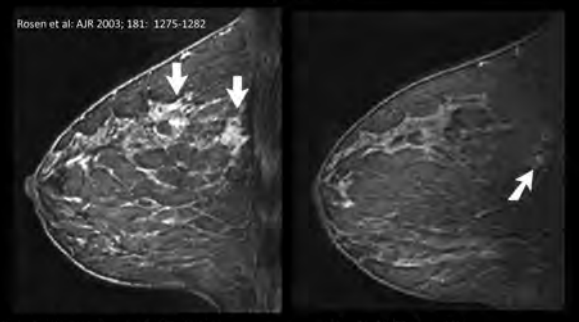


Rosen et al: AJR 2003; 181: 1275-1282

Pre = 3.6 cm

Post = 1.9 cm
Histo 0.9 cm tumor and FC change

Underestimation 39 yo IDC



Rosen et al: AJR 2003; 181: 1275-1282

Pre – nonfocal, segmental enhancement

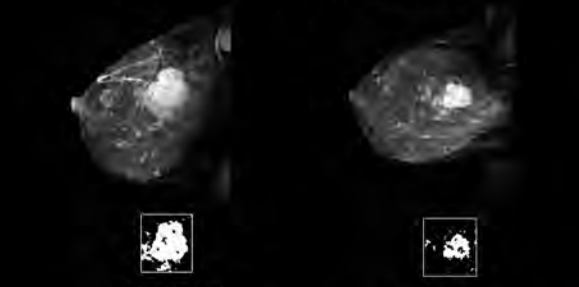
Post –small focal residual
Histo: Multifocal DCIS 7/31 specimens

MRI of tumor volume**

- Assess MRI measurement of breast tumor size in predicting recurrence free survival (RFS)
- 62 patients underwent neoadjuvant cheomRx
- MRI volume strongest predictor of RFS
- More predictive than MRI diameter or PE
- MRI volume best predictor of RFS

Partridge et al: AJR 2005;184; 1774-1781

50 yo IDC Disease free at 20 months



4.7 cm in diameter
22 cm^3

2.2 cm in diameter
30% decrease in volume

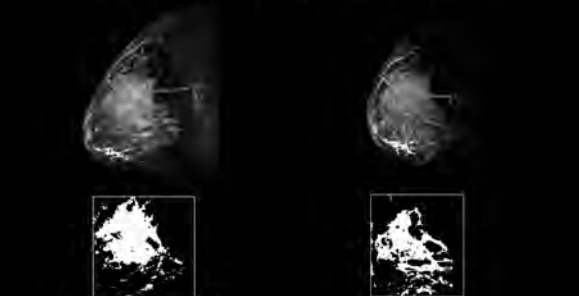
Partridge et al: AJR 2005;184; 1774-1781

50 yo with IDC Disease free at 20 months

88% decrease in volume

Partridge et al: AJR 2005;184; 1774-1781

41 yo, grade III IDC Recurrence at 8 months

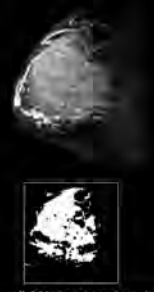


6.2 cm in diameter, 71 cm^3

After one cycle of Rx

Partridge et al: AJR 2005;184; 1774-1781

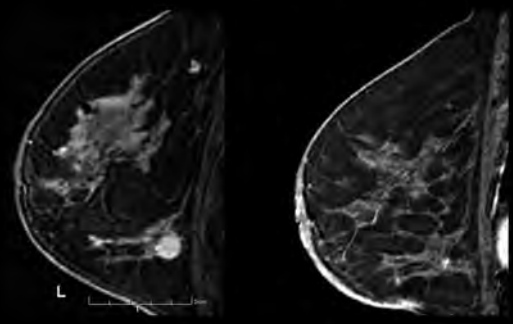
41 yo, grade III IDC
Recurrence at 8 months



Overall 28% increase in volume

Partridge et al: AJR 2005;184; 1774-1781

Neoadjuvant chemotherapy



Argus et al. Applied Rad 39, Oct 2010

MRI after excisional Bx for BC**

- 5304 breast MRI examinations
- 308 evaluated post-excisional Bx
- 203 not treated with chemo or RadRx
- Enhancement patterns:
  - P1: No enhancement
  - P2: Thin regular rim enhancement
  - P3: Thick or irregular rim enhancement
  - P4: Nodular or non mass-like enhancement

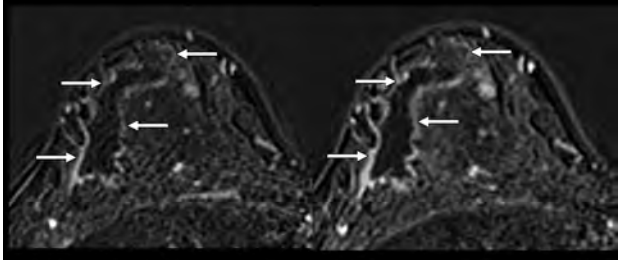
**Chae et al: AJR 2013; 200: 1167-1173
Asan Med Center, Seoul, Korea

MRI after excisional biopsy for BC

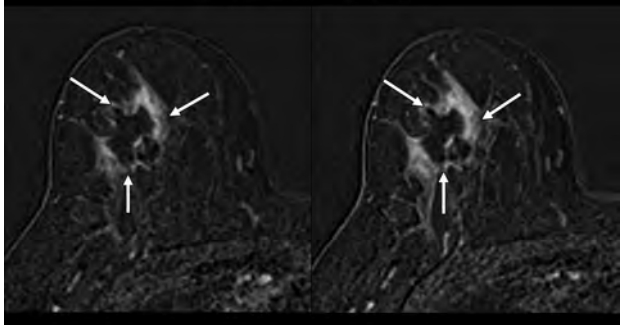
- P1 and P2 = no residual tumor
- P3 and P4 = positive for residual tumor
- Of 207 MRI exams in 203 pts
  - 144 with residual tumor at histology after definitive surgery
  - MRI specificity 90.5%, PPV 91.7%
- Contrast enhanced breast MRI is a useful tool for residual dz prediction after excisional biopsy

**Chae et al: AJR 2013; 200: 1167-1173
Asan Med Center, Seoul, Korea

No residual tumor



Residual tumor

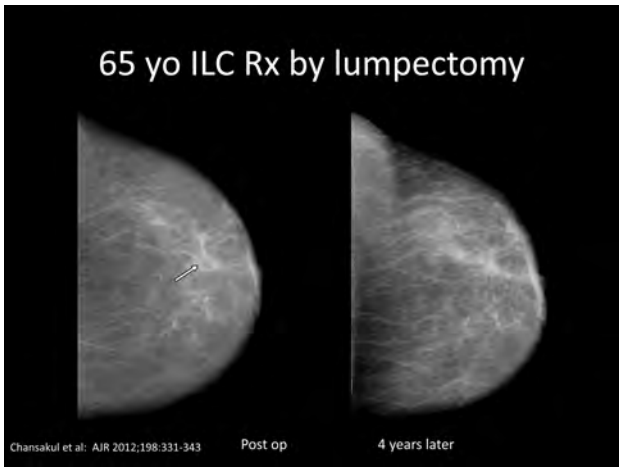


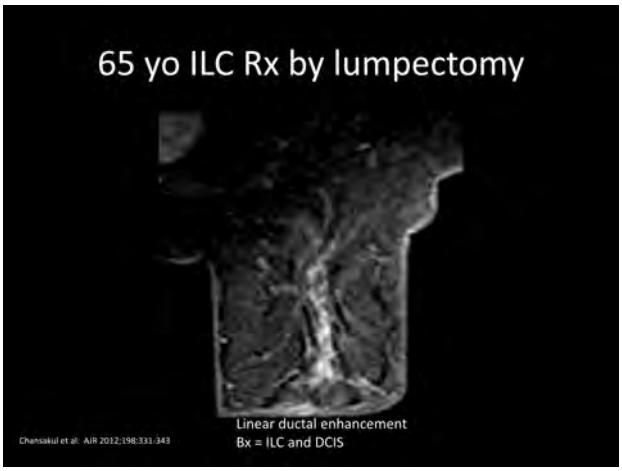
MRI for assessing tumor recurrence

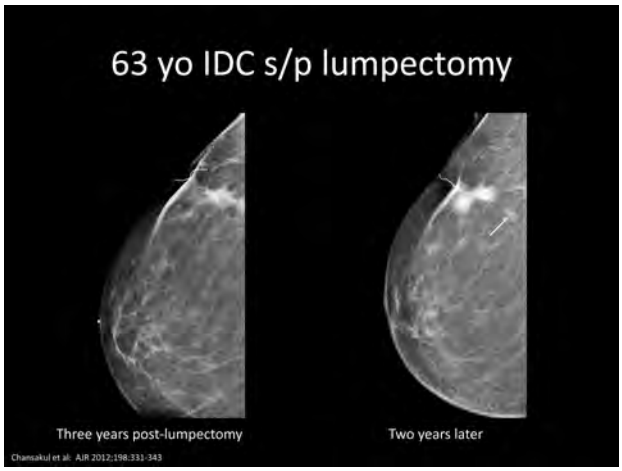
- Recurrence after breast conservation in postoperative site 2.5%/year from 2-6 years
- Risk of local recurrence for 10 years
- Recurrence > 10 years outside operative site
- Recurrent tumor may in situ or invasive
- If dx by microca++, recurrence ca++ look the same

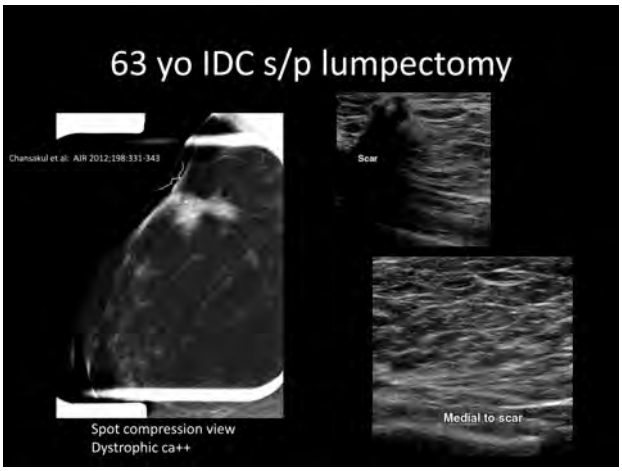
MRI for assessing tumor recurrence

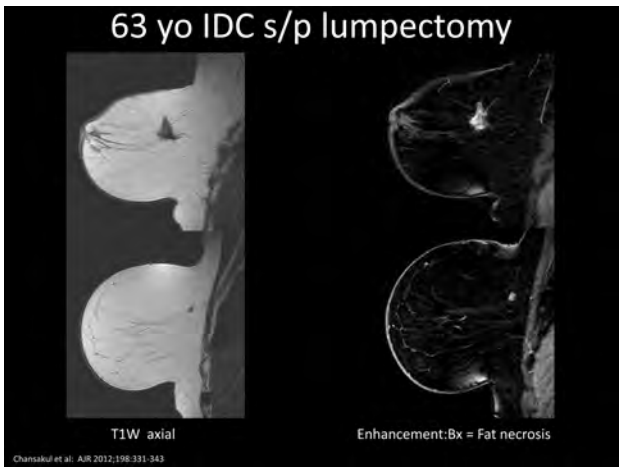
- Mammography not sensitive for scar vs recurrent tumor
  - Sensitivity 55-68%
- MRI best used 12-18 months after Rx
- No enhancement = scar
- Enhancement requires WU
  - Fat necrosis can avidly enhance
- Overall MRI performance:
  - Sensitivity 90-100%
  - Specificity 83-93%

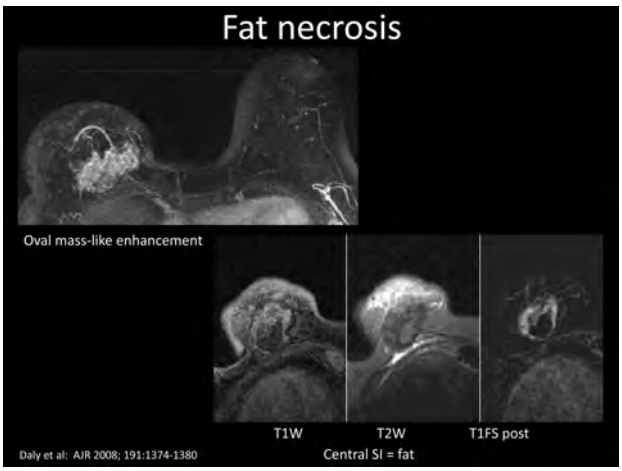

65 yo ILC Rx by lumpectomy
Chansakul et al: AJR 2012;198:331-343
Post op
4 years later

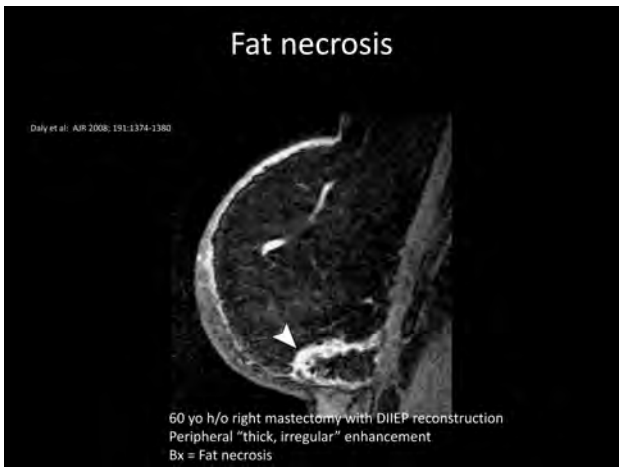

65 yo ILC Rx by lumpectomy
Chansakul et al: AJR 2012;198:331-343
Linear ductal enhancement
Bx = ILC and DCIS

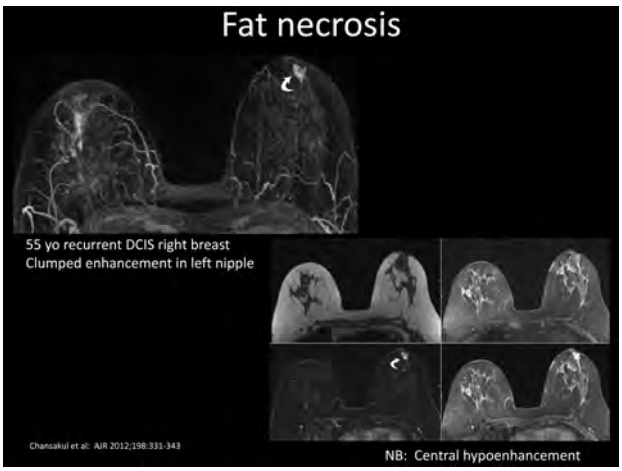

63 yo IDC s/p lumpectomy
Three years post-lumpectomy
Two years later
Chansakul et al: AJR 2012;198:331-343


63 yo IDC s/p lumpectomy
Chansakul et al: AJR 2012;198:331-343
Scar
Medial to scar
Spot compression view
Dystrophic ca++


63 yo IDC s/p lumpectomy
T1W axial
Enhancement:Bx = Fat necrosis
Chansakul et al: AJR 2012;198:331-343


Fat necrosis
Oval mass-like enhancement
T1W
T2W
T1FS post
Daly et al: AJR 2008; 191:1374-1380
Central SI = fat


Fat necrosis
Daly et al: AJR 2008; 191:1374-1380
60 yo h/o right mastectomy with DIIEP reconstruction
Peripheral "thick, irregular" enhancement
Bx = Fat necrosis


Fat necrosis
55 yo recurrent DCIS right breast
Clumped enhancement in left nipple
Chansakul et al: AJR 2012;198:331-343
NB: Central hypoenhancement

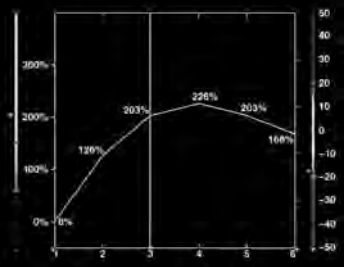
Fat necrosis

Typical fat necrosis ca++

Daly et al: AJR 2008; 191:1374-1380

Fat necrosis

- Always compare with mammography
- Lipid cyst most common appearance
- Thin rim enhancement with central nonenhancement typical
- But has various degrees of enhancement
- May persist for years after surgery

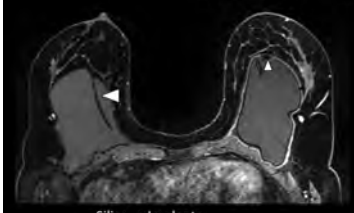


Fat necrosis enhancement curve

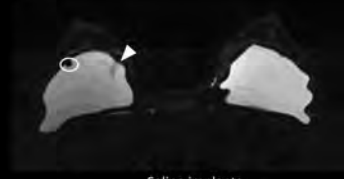
Breast implant evaluation

- Breast augmentation commonly performed
- Silicone and saline most common
- Complications:
  - Perimplant fluid collection
  - Capsular contraction (clinical Dx)
  - Rupture
  - Gel bleed

Normal "folds"



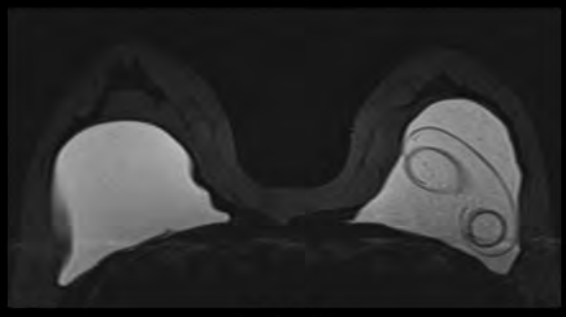
Silicone Implants



Venkataraman et al: AJR 2011; 197: W10031-W1045

Saline implants

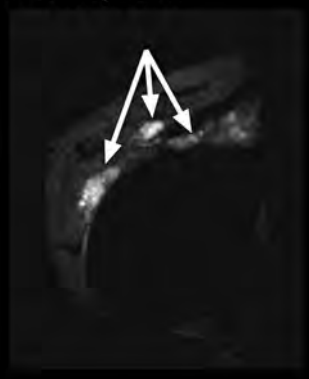
Intracapsular rupture



"Linguine" sign

Venkataraman et al: AJR 2011; 197: W10031-W1045

Extracapsular rupture



Venkataraman et al: AJR 2011; 197: W10031-W1045

Breast MRI as "problem solving"

- Somewhat controversial and "local"
- Equivocal mammographic abnormality or 3D localization of lesion seen on only ONE view
  - Asymmetries
  - Architectural distortions
  - Evaluation of surgical or biopsy sites
- Negative predictive value of MR in this setting about 85% (not high enough to exclude Bx)

Breast MRI as "problem solving"**

- 115 MRI exams for "problem-solving" for inconclusive mammographic findings
- Most common indications:
  - Asymmetry
  - Architectural distortion
- 48/115 (42%) high risk
- No MRI correlate in 100 patients (87%)

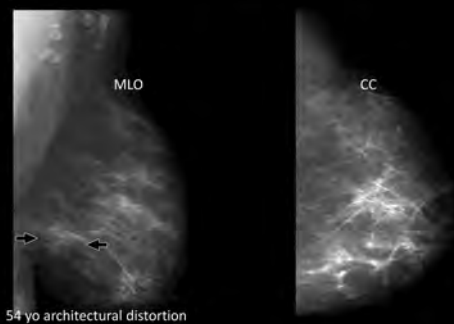
Mahoney et al: AJR 2009; 193: 1493-1499

Breast MRI as "problem solving"**

- Enhancing masses corresponding to mammographic findings in 15 (13%)
- All masses localized and underwent Bx
  - 6 were malignant
  - 4/6 seen in only one mammo view
  - 2/6 seen on 2cd look US
- MRI:
  - Sensitivity of 100% (Mammo 91.7%)
  - PPV 40% (Mammo 8.7%)
  - Overall accuracy 92,2% (Mammo 72.3%)

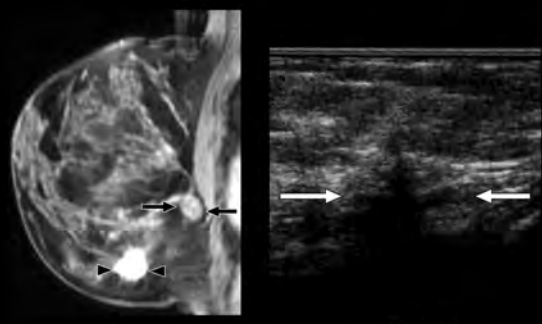
Moy et al: AJR 2009; 193: 986-993

Asymmetry



54 yo architectural distortion
US-guided Bx = FA ~Discordant
Moy et al: AJR 2009; 193: 986-993

Asymmetry



Baseline mammogram
Asymmetry MLO, US neg

Breast MRI negative
Short term FU recommended

MRI Breast Cancer Screening
Very High Risk

- BRCA mutation
- First degree relative of BRCA, but untested
- Prior chest radiation between ages 10 and 30
- Syndromes with propensity for developing BC
  - Li - Fraumeni Sx
  - Cowden Sx
  - Lynch Sx-Hereditary Non-polyposis Colorectal Cancer Sx
  - Familial Adenomatous Polyposis IFAP)
  - Von Hippel-Lindau
  - Multiple Endocrine Neoplasias
- Patients with lifetime risk of BC of > 20 to 25% by risk models

Li—Fraumeni Syndrome

- Extremely rare (~ 400 families reported)
- AD
- The "sarcoma, breast, leukemia and adrenal gland (SBLA) syndrome
- Germline mutations of the p53 tumor suppressor gene
- Risk of invasive cancer ~ 50% by age 30 and 90% by age 70
- Recommendations/Sugge stions:
  - Avoid radiation therapy
  - Comprehensive annual PE
  - Women start BC surveillance at age 25
  - Consult physician promptly for symptoms/illness
  - Adults undergo screening for colorectal cancer no later than 25 yo
  - ? prophylactic mastectomy?

MRI screening in BRCA1/BRCA2

- National Comprehensive Cancer Network (NCCM)
  - Monthly BSE beginning in early adulthood
  - Semiannual CBE (begin at 25 yo)
  - Annual mammogram (beginning 25-25 yo)
  - Annual breast MRI (beginning 25-35 yo)

MRI of occult tumor in high risk population**

- Retrospective review 367 consecutive women at high risk
  - Normal mammograms
  - First MRI screening exam over 2 year period
- Biopsy recommended in 64 women (17%)
- 14/59 (24%) had occult cancer on biopsy
  - DCIS in 8 (57%)
  - Infiltrating cancer in 6 (43%)
  - Median cancer size 0.4cm (range 0.1-1.2cm)

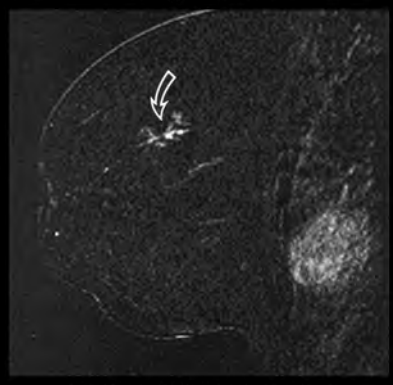
**Morris et al. AJR 2003; 181:619-626

MRI of occult tumor in high risk population**

- Positive nodes for cancer in two women
- Bx revealed high risk lesions (ADH, ALH, LCIS and radial scar) in 13 (4%) of 367 patients
- Bx showed B9 findings in 32 (9%) of 367 patients
- MRI screening led to 17% recommendation for Bx
  - Cancer in 24% of women Bx and 4% of all high risk women

**Morris et al. AJR 2003; 181:619-626

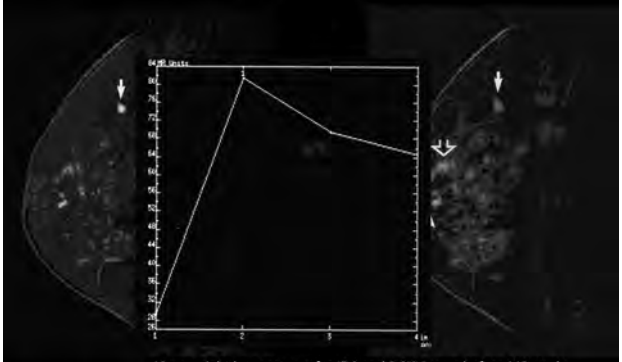
High risk



48 yo IDC and DCIS , lumpectomy 3 yrs ago
Bx = DCIS, papillary and cribiform type

Morris et al. AJR 2003; 181:619-626

High risk



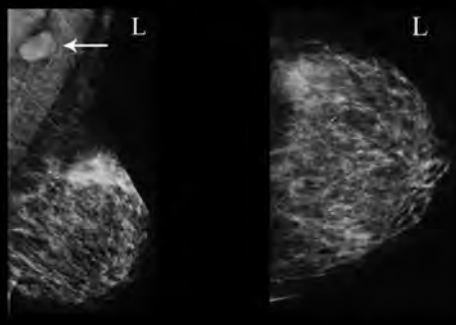
42 yo – right lumpectomy for IDC and DCIS 1 year before MR study
MR NL revealed invasive DCIS (0.3 cm) with DCIS

Morris et al. AJR 2003; 181:619-626

MRI Breast Cancer Screening Intermediate Risk/Insufficient Proof

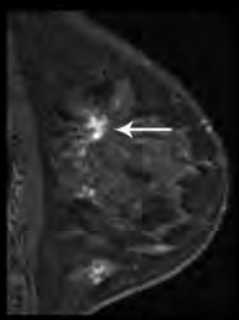
- Lifetime risk of BC of 15-20% defined by risk models
- Prior Dx of atypia or LCIS
- Dense breasts on mammography
- Personal hx of BC

Metastatic axillary nodes



Argus et al. Applied Rad 39, Oct 2010

Metastatic axillary nodes



Argus et al. Applied Rad 39, Oct 2010

Summary

- Many different indications for breast MR imaging
- Some are being continually defined
- Need more research on which are cost-beneficial
- Ongoing focus of breast imaging research
- And, there may be other competing technologies—which we will discuss in another lecture