Imaging Guided Interventions: Focus on Architectural Distortion

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Overview
- Definition
- Etiologies
- Diagnostic evaluation
- Methods for tissue sampling
- Radiology pathology concordance

BI-RADS Definition: Mammography
- Thin straight lines or spiculation radiating from a point

BI-RADS Definition: Mammography
- Focal retraction, distortion, or straightening at the anterior or posterior edge of the parenchyma

BI-RADS Definition: Mammography
- May be associated with asymmetry or calcifications
- Can also be an associated feature of a mass

AD = “Black star”
BI-RADS Definition: Ultrasound

- Listed as associated feature
- Compression of the tissue around the mass
- Obliteration of the tissue planes by an infiltrating lesion
- Straightening or thickening of Cooper’s ligaments
- Aberrations of ductal pattern

BI-RADS Definition: MRI

- Associated feature
- Used in conjunction with another finding to indicate that the parenchyma is distorted or retracted adjacent to the finding

Architectural Distortion

- Third most common imaging appearance of breast cancer
- 12-45% of missed breast cancers on 2D screening mammography

Detection of AD

- Increased with DBT
  - Better visualized due to reduced superimposition
  - May reveal underlying mass with distortion
**Is there really AD?**

- One of lowest levels of interobserver agreement
- Agreement in mammographic interpretation was 43% for AD vs 100% for masses
- Agreement among 10 experienced academic breast radiologists for AD fair (k=0.67)
- Significantly lower sensitivity for AD vs. non-AD

**Table:**

<table>
<thead>
<tr>
<th>Study</th>
<th>Recall rate (% exams)</th>
<th>PPV3</th>
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<tbody>
<tr>
<td></td>
<td>DM</td>
<td>DBT</td>
</tr>
<tr>
<td>Lourenco Radiology, 2015</td>
<td>0.6%</td>
<td>5.3%</td>
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<tr>
<td>Vijapura AJR, 2018</td>
<td>0.3%</td>
<td>0.6%</td>
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<tr>
<td>McDonald Radiology, 2017</td>
<td>6.1%</td>
<td>9.9%</td>
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<tr>
<td>Bahl AJR, 2017</td>
<td>0.07%</td>
<td>0.14%</td>
</tr>
<tr>
<td>Partyka AJR, 2014</td>
<td>-</td>
<td>0.5%</td>
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*mammogram exams (diagnostic and screening)*

**Architectural Distortion?**

- Radial scar
- DCIS
- Superimposition
- Sclerosing adenosis
- DO NOT COPY

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Interobserver Variability

- 3 readers agreed on presence of AD in only 26 of 51 recalls for AD.¹
- 181 AD (122 2D, 59 DBT), 3 readers:²
  - Fair agreement, $\kappa = 0.29-0.37$
  - Moderate to substantial agreement for level of suspicion
    - $\kappa = 0.51-0.64$, 79.3-84.4% agreement
    - $\kappa = 0.32-0.36$ for 2D-detected lesions
    - $\kappa = 0.14-0.36$ for DBT-detected lesions

Increased Agreement with DBT

- 59 AD patients and 59 controls, 4 readers
- DBT vs 2D:
  - decreased interobserver variability
  - increased reader confidence
  - improved sensitivity

Etiologies

- Malignancy
- Radial scars and complex sclerosing lesions
- Post-procedural scars from surgery, biopsy, reduction mammoplasty
- Fibrosis
- Fat necrosis
- Sclerosing adenosis
- Fibromatosis with fibroblastic and myofibroblastic proliferation

Correlate with Clinical History

- In absence of history of trauma or surgery, AD is considered suspicious $\Rightarrow$ tissue diagnosis

Post-surgical AD

Diagnostic Evaluation of AD

- If presumed post-surgical, confirm with scar marker
Post-surgical AD?

65-year-old submits outside imaging for review.

AD confirmed to be post-surgical after placement of linear radiopaque scar marker.

Diagnostic Evaluation of AD

- If not post-surgical:
  - Lateral and spot compression views
  - Beware of potential for cancer to "spot away"
  - If one view only, utilize the scroll bar or adjacent landmarks for lesion localization

Two persistent areas of architectural distortion.

Ultrasound

- Perform for mammographically suspicious AD to allow for US biopsy
- PPV for malignancy greater with US correlate
- If US correlate is vague, use skin marker (BB) to confirm correlation
Invasive mammary carcinoma, grade 1 and DCIS, grades 1 and 2

Invasive ductal carcinoma with tubular features, grade 1 and DCIS, grades 1 and 2

40-year-old recalled from baseline screening mammography

Use adjacent landmarks to correlate subtle US correlate.

Biopsy revealed radial scar.

40-year-old recalled from baseline screening mammography

Diagnostic Evaluation

Subtle distortion noted on US. Correlate?

MG US correlation with BB

Post-biopsy clip confirmation

Dense stromal fibrosis up to 0.8 cm.
62-year-old woman annual mammography

Post-biopsy clip correlation

US biopsy: grade 1 IDC with tubular features

47-year-old recalled from screening mammography

US biopsy clip does not correlate

Stereotactic biopsy was performed


Tissue Sampling

- If US correlate, US biopsy can be performed with confirmation of clip on post-biopsy MG
- AD without US correlate has PPV >2% → therefore tissue sampling warranted
### Tissue Sampling

- If no US correlate:
  - DBT-guided biopsy
  - Stereotactic biopsy utilizing landmarks
  - Excisional biopsy after DBT needle localization
  - MRI for problem solving
  - CESM for problem solving

### Study

<table>
<thead>
<tr>
<th>Study</th>
<th>% cancer DBT-only AD</th>
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<tr>
<td>Partyka AJR, 2014</td>
<td>21% (4/19)</td>
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<tr>
<td>Freer Radiology, 2015</td>
<td>47% (17/36)</td>
</tr>
<tr>
<td>Ray Breast J, 2015</td>
<td>36% (5/14)</td>
</tr>
<tr>
<td>Patel AJR, 2018</td>
<td>26% (9/34)</td>
</tr>
<tr>
<td>Alshafeiy Radiology, 2018</td>
<td>10% (6/59)</td>
</tr>
<tr>
<td>Pujara Clin Imaging, 2019</td>
<td>9% (1/11)</td>
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61-year-old recalled from screening mammography for AD in the outer right breast and upper outer left breast.

Diagnostic mammography demonstrated persistent AD in the R outer and L UOQ.

No ultrasound correlate.

Bilateral DBT biopsy recommended.
Post-biopsy clip confirmation

Radial scar
- Benign lesion characterized by a central fibroelastic core surrounded by radiating ducts and lobules
- Referred to as complex sclerosing lesions if >1 cm in size
- 14-26% of patients at autopsy
- 0.9 per 1000 prevalence screening exams
- 0.8-1.8% of image-guided biopsies

Radial scars and breast cancer
- Not premalignant lesions
- Proliferative lesions that often coexist with other proliferative lesions, including atypia, that may contribute to upgrade
- Coexist with cancers at a higher frequency than chance alone
- Likely does not impart increased risk of future breast cancer

Upgrade of Radial Scars
- Upgrade rate 0-43% (usually to DCIS):
  - sampling method
  - biopsy device and gauge
  - number of samples
  - targeted abnormality
  - associated atypia
  - criteria for excision (selection bias)
  - imaging-pathology concordance/discordance

Bilateral radial scars

Upgrade of Radial Scars
- Larger-gauge vacuum-assisted devices and more cores → significantly lower upgrade rates
  - For RS without atypia:
    - 5% 14G CNB
    - 2% 8-16G CNB
    - 1% VAB
- Cancers often identified in a peripheral location within radial scars → potential undersampling at CNB site

References:
Management of Radial Scars

- Traditionally surgical excision due to risk of associated malignancy based on film-screen, FFDM and/or US findings
- Review: upgrade rate pure RS – 3.4% (0-16%)\(^1\)

DBT and Radial Scars

- DBT \(\Rightarrow\) increased AD \(\Rightarrow\) increased RS
  - 15.3% of HRL in DBT group vs. 9.7% in DM group\(^1\)
  - 33.2% of AD in DBT group vs. 11.6% in DM group\(^2\)
  - 0.13% of exams in DBT group vs 0.04% in DM group\(^3\)
  - Associated malignancy rate 2.29\(^6\), 1.45\(^4\)

Radial scars without atypia

- Low upgrade rates reported:
  - 0% (0/100)\(^1\)
  - 0% (0/39, 0/13, 0/15)\(^2,4\)
  - 2% (2/91)\(^5\)
  - 4% (5/128 – AD 3/5 cases)\(^6\)

MRI for Radial Scars

- High risk lesions, including 54 radial scars
  - NPV for radial scar = 97.6%
  - 1 FN: low-grade DCIS
  - Clinical and imaging follow-up with normal MR findings?

Radial Scar Management: Controversial

- Excise all?
- Case by case analysis?
- Imaging and clinical follow-up?

Management Considerations

- Has target been sufficiently sampled?
  - Consider # cores and gauge, lesion size
  - Is clip in appropriate position?
- Is pathology concordant with imaging findings?
- Is radial scar incidental?
- Patient factors: current cancer or personal history of breast cancer, high risk factors
Potential Management Algorithm: Radial Scars

- <1 cm, concordant → imaging follow-up
- >1cm, concordant → consider excision or repeat sampling with large gauge vacuum-assisted device
- Incidental, concordant → imaging follow-up


57-year-old woman recalled from screening mammography.

Metallic BB for US-MG correlation

Biopsy clip not in area of AD. Attempted stereotactic biopsy unsuccessful. Next step?

No suspicious enhancement identified in either breast. Six month follow-up MG recommended.

? architectural distortion
On follow-up MG, persistent AD. Stereotactic biopsy recommended.

Pathology: Breast tissue with intraductal papilloma (0.2 cm), sclerosing adenosis, usual ductal hyperplasia, apocrine metaplasia, columnar cell change, columnar cell hyperplasia, microcysts and microcalcifications.

CONCORDANT?

Pathology: Breast tissue with intraductal papilloma (0.2 cm), sclerosing adenosis, usual ductal hyperplasia, apocrine metaplasia, columnar cell change, columnar cell hyperplasia, microcysts and microcalcifications.

After review of pathology and imaging at Radiology Pathology concordance conference, pathology was considered benign and concordant.

Six month mammographic follow-up was recommended.

Due to concern for developing mass/asymmetry associated with AD, surgical excision was recommended.

Surgical pathology: ID papillomas, sclerosing adenosis, UDH, PASH.

Re-review of pathology: significant fibrosis felt to account for the AD.
60-year-old recalled from screening mammography.

Persistent AD in the upper outer left breast. No ultrasound correlate. Stereotactic biopsy was recommended.

Diagnostic Mammogram

Post-biopsy mammogram after stereotactic biopsy

Biopsy clip inferior to the distortion. No recurrence.

A 1.2 cm irregular enhancing mass was identified at 2:00 in the left breast corresponding to the area of distortion.

MR biopsy was performed.

Pathology: Part of a radial scar (0.5 cm), ALH

Surgical pathology: Radial scar

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MRI for Problem Solving

- Frequency should be low
  - 1.3-4% of MR exams
  - 0.7-0.14% of Dx mammograms

Problem-Solving MRI

- Moy: 12 AD, 7 one-view only
  - Malignancy rate 8.3% (one-view AD)
  - Overall Sensitivity 100%, NPV 100%

- Spick: 57 AD
  - TP 8, TN 44, FP 5, FN 0
  - Malignancy rate 14%
  - Sensitivity 100%, NPV 100%

MRI for Equivocal DM/DBT Findings

- 67 equivocal DM/DBT findings
  - 9 (13%) one-view AD: 2 MRI findings, 0 cancer
  - 10 (15%) two-view AD: 4 MRI findings, 1 cancer
  - Overall malignancy rate 7% (5/67)
  - PPV 19%, NPV 98%

MRI for Equivocal DBT Findings

- 107 DBT-only lesions (79 AD, 28 asymmetries)
  - 50/79 AD had correlative MR finding
  - 14/50 (28%) invasive carcinoma
  - 36/50 (72%) benign
  - MR negative: no cancers at average follow-up of 32 months
56-year-old recalled from screening mammography.

**Diagnostic Mammogram**

Persistent AD R upper posterior breast.
No US correlate.
Stereotactic biopsy recommended.

**Diagnostic Mammogram**

Attempted stereotactic biopsy unsuccessful.
Breast MRI recommended for further evaluation.

**Post-biopsy Mammogram**

2.5 cm NME right UOQ which may correlate with AD. MR biopsy recommended.

Incidental 0.7 cm enhancing mass left 3:00. MR biopsy recommended.

Both MR biopsies benign. R MR biopsy clip is anterior to the area of AD.

Re-attempted stereotactic biopsy yielded a radial scar.

Next step?
72-year-old referred from OSH for MRI evaluation of AD L UOQ, no US correlate.

No suspicious enhancement on MRI.

DBT biopsy = ADH, part of a complex sclerosing lesion.

Surgical pathology = grade 1 IDC, grade 2 DCIS.

MRI for Problem Solving

- Can be used for equivocal mammographic lesions
- Negative or benign MR: ambiguous finding likely not clinically significant \(\rightarrow \) can do f/u
- Positive MR finding: increases clinical suspicion and can guide tissue diagnosis
- Not appropriate for suspicious, two-view mammographic findings for which biopsy is recommended
  - NPV of MR not considered high enough to obviate tissue diagnosis

Diagnostic Algorithm

- Architectural distortion
  - Ultrasound
    - If US correlate
      - US biopsy
    - No US correlate
      - MR
  - DBT biopsy
  - Stereotactic biopsy if seen on 2D
- MRI
  - MR correlate
  - MR biopsy
  - No MR correlate
    - DBT needle localization
    - Consider short-interval follow-up if AD is equivocal
CESM for AD

- 49 AD with CESM prior to biopsy
  - 29 invasive cancers, 1 DCIS, 9 radial scars, 10 benign
  - 76% (37/49) AD showed enhancement
  - Sensitivity 97%, NPV 92%
  - 1 FN: 4 mm lesion within substantial BPE

62-year-old recalled from screening mammography for AD in the R UIQ. History of 2 benign R MR biopsies for NME.

2016 2017 2019

Post-biopsy change?

After first US pass, unable to visualize the lesion. DBT guided biopsy performed.

US biopsy: stromal fibrosis (not shown)

DBT biopsy: grade 2 ILC
AD and Cancer Types

- More common in Luminal A and B tumors
- Lower grade tumors
  - 96% malignancies low or intermediate grade
- Lobular histology
  - Most are invasive (>80%) vs DCIS
  - DCIS more common for DBT-only AD

Can imaging features help predict malignancy?

- Greater likelihood of malignancy with US correlate
  - 39.7% vs 11.1%
  - 46% vs 15%
  - 82.9% vs 27.9%
  - 97% vs 83%
  - 66.5% vs 29.2%

Can imaging features help predict malignancy?

- Greater likelihood of malignancy with 2D vs DBT
  - 43.5% vs 10.2%
  - 88% vs 68%
  - 73.6% vs 50.7%

Can imaging features help predict malignancy?

- Trend toward increased malignancy rate for AD with Ca++ or asymmetries vs pure AD on DM
  - One-view only distortion can be malignant
  - 23% (3/13) one-view AD malignant
  - 2 of 3: ILC
  - All seen on CC view only
Can imaging features help predict malignancy?

- Nonmalignant AD:
  - symmetric or spoke-wheel spiculation with central lucency
- Malignant AD:
  - asymmetric spiculation and central mass
- Nonmalignant AD either better detected or detected only on DBT.

**Challenge Cases: Multiple AD**

48-year-old recalled from screening mammography.
No definite sonographic abnormality identified to correspond to the numerous areas of architectural distortion seen on mammography.

Management?

Radial Scar Appearance on MRI

- 29 radial sclerosing lesions\(^1\)
  - 9 occult on MRI
  - 20 MRI: 1 focus, 10 masses, 4 NME, 5 "AD"
  - 7/9 RSL presenting as AD were visible on MR
- 18/30 AD were radial scars\(^2\)
  - None showed enhancement on MRI

Surgical excision was not performed.

No interval mammographic change over 3 years.

55-year-old with prior excision of radial scar/FEA, recent L stereotactic biopsy (AD) at MRI revealing radial scar.
DBT biopsy AD left central inner, left central, and right upper inner breast and US biopsy hypoechoic mass right at 9:00 2 cm from the nipple recommended.

Management?

Surgical Pathology

- Left medial: multiple radial scars, multiple intraductal papillomas, sclerosing adenosis
- Left lateral: multiple radial scars, multiple intraductal papillomas with associated UDH
- Right breast lateral: multiple radial scars, multiple intraductal papillomas, sclerosing adenosis, PASH
- Right inferior: multiple radial scars, ALH, FEA, multiple papillomas, PASH
Multiple Radial Scars

- Nurses’ Health Study: 460 cases and 1792 controls with BBD
- Among women with RS
  - One RS 67.3%
  - Two RS 16.7%
  - >3 RS 16.0%
- Women with multiple RS at higher risk of breast cancer than women with single RS (RR 2.7 vs 1.5, p = 0.12)

Left DBT biopsy
Pathology: DCIS, grades 2 and 3 with lobular extension into a radial scar

Right DBT biopsy
Pathology: DCIS, grade 3 with lobular extension and focal microinvasion.

51-year-old recalled from screening mammography.

US biopsy revealed DCIS involving a complex sclerosing lesion.
Persistent AD left subareolar region. No US correlate. DBT biopsy revealed ADH and sclerosing adenosis.

Right MR biopsy revealed ADH bordering on DCIS.

Bilateral Surgical Excision

Right: DCIS, ADH
Le: DCIS, ADH, FEA

Management of Biopsy Results for AD

- Malignant → excise
- High risk lesions
  - ADH → excise
  - Pleomorphic LCIS → excise
  - Radial scar → controversial
- Benign → nothing additional if adequate sampling and rad-path concordance

85-year-old recalled from screening mammography. History of bilateral lumpectomies.

Persistent AD upper central left breast.
Ultrasound Correlate

Post-biopsy clip correlation

Needle localization for surgical excision

Radiology-Pathology Concordance is Key!

Summary

- AD is the most commonly missed manifestation of cancer with high interobserver variability
- Increased detection of AD with DBT
- Higher rate of malignancy with US correlate
- DBT-only AD warrants biopsy
- Careful post-biopsy evaluation paramount:
  - Radiology-pathology concordance
  - Post-biopsy clip correlation

Pathology: cystic apocrine metaplasia, sclerosing adenosis, columnar cell changes, cysts.

CONCORDANT?

Grade 2 IDC and DCIS.