乳がんに対する放射線技術

～検査（治療）におけるピットホールとその対策について考える～

MRI

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Today's Contents

- 乳房MRIの特徴と適応
- BIRADS MRI 2013について
- 乳房MRIの撮像プロトコル
- 乳房MRIのピットホールと対策
- Abbreviated MRI

乳房MRIの特徴

VOLUME 28 · NUMBER 9 · MARCH 20 2010
JOURNAL OF CLINICAL ONCOLOGY ORIGINAL REPORT

Prospective Multicenter Cohort Study to Refine Management Recommendations for Women at Elevated Familial Risk of Breast Cancer: The EVA Trial

Weigel, Simone Schrading, Birke Arand, Heribert Bieling, Roy König, Leutner, Andrea Rieber-Brambs, Dennis Nordhoff, Walter Heindel, ans H. Schild

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A B S T R A C T

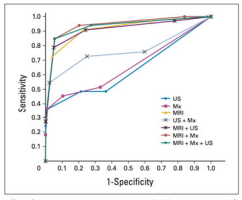


Fig 2. Receiver operating characteristic analysis. Mx, mammography; US, ultrasound; MRI, magnetic resonance imaging.

spective contribution (in terms of cancer yield and stage at diagnosis) of ion (CBE), mammography, ultrasound, and quality-assured breast magnetic II), used alone or in different combination, for screening women at elevated

observational cohort study. Six hundred eighty-seven asymptomatic women ≥ 20% lifetime) underwent 1,679 annual screening rounds consisting of CBE, nd, and MRI, read independently and in different combinations. In a subgroup al half-yearly ultrasound and CBE was performed more than 869 screening an follow-up was 29.18 and 29.09 months.

乳がん診断におけるMRIの役割

1. 存在診断
   - ハイリスク症例のスクリーニング
   - 原発不明癌の精査
   - 術後乳房
     a. 乳房温存術後の残存病変の検出
     b. 乳房再建術後の再発評価
     c. インプラント乳房内の乳癌検出
2. 質的診断
   - Inconclusive diagnosis
   - 術後乳房
     a. 乳房温存術後の瘢痕と再発の鑑別
3. 術前評価
   - 乳管内癌の有無と広がり診断
   - 周囲(大胸筋および皮膚)への浸潤の評価
   - 同側および対側の多発癌の検出
4. 化学療法症例の評価

BI-RADS MRI 2013

① 読影用語の標準化
② 所見に基づいたカテゴリー分類とそれに応じたマネジメントを含む報告の標準化
③ 読影の精度管理

Assessment	Management	Likelihood of Cancer
Category 0: Incomplete	Recall for additional imaging	N/A
Category 1: Negative	Routine screening	Essentially 0% likelihood of malignancy
Category 2: Benign	Routine screening	Essentially 0% likelihood of malignancy
Category 3: Probably Benign	Short-interval follow-up or continued surveillance	> 0% but ≦ 2% likelihood of malignancy
Category 4: Suspicious	Tissue diagnosis	> 2% but < 95% likelihood of malignancy
Category 4A: Low suspicion for malignancy		> 0% but ≦ 10% likelihood of malignancy
Category 4B: Moderate suspicion for malignancy		> 10% but ≦ 50% likelihood of malignancy
Category 4C: High suspicion for malignancy		> 50% but < 95% likelihood of malignancy
Category 5: Highly Suggestive of Malignancy	Tissue diagnosis	≧ 95% likelihood of malignancy
Category 6: Known Biopsy-Proven Malignancy	Surgical excision when clinically appropriate	N/A

Amount of fibroglandular tissue (FGT)	a: Almost entirely fat b: Scattered fibroglandular tissue c: Heterogenious fibroglandular tissue d: Extreme fibroglandular tissue		Associated features	Nipple retraction Nipple invasion Skin retraction Skin thickening	
Background parenchymal enhancement (BPE)	Level	Minimal Mild Moderate Marked		Skin invasion	Direct invasion Inflammatory cancer
	Symmetric or asymmetric	Symmetric Asymmetric		Axillary adenopathy Pectoralis muscle invasion Chest wall invasion Architectral distortion	
Focus			Fat containing lesions	Lymph nodes	Normal Abnormal
Masses	Shape	Oval Round Irregular		Fat necrosis Hamartoma Prospective seroma/hematoma with fat	
	Margin	Circumscribed Not Circumscribed - Irregular - Spiculated	Location of lesion	Location Depth	
	Internal enhancement characteristics	Homogeneous Heterogeneous Rim enhancement Dark internal septations	Kinetic curve assessment	Initial phase	slow Medium Fast
Non-mass enhancement (NME)	Distribution	Focal Linear Segmental Regional Multiple regions Diffuse		Delayed phase	Persistent Plateau Washout
	Internal enhancement patterns	Homogeneous Heterogeneous Clumped Clustered ring	Implants	Implant material and lumen type	Saline Silicone - Intact - Ruptured Other implant material Lumen type
Intramammary lymph node				Implant location	Retroglandular Retropectoral
Skin lesion				Abnormal implant contour	Focal bulge
Non-enhancing findings	Ductal precontrast high signal on T1WI Cyst Postoperative collections (hematoma/seroma) Post-therapy skin thickening and trabecular thickening Non-enhancing mass Architectural distortion Signal void from foreign bodies, clips, etc.			Intracapsular silicone findings	Radial folds Subcapsular line Keyhole sign Linguine sign
				Extracapsular silicone	Breast Lymph nodes
				Water droplets Peri-implant fluid	

Amount of fibroglandular tissue (FGT)

- 今回の改定により記載することが明記された
- マンモグラフィの乳腺濃度と同等のものに相当し，独立した因子であり，乳がんリスクともかかわっていると言われる
- 非造影の時点で乳腺組織の量がどの程度あるかを評価する

a: Almost entirely fat

b: Scattered fibrogladular tissue

c: Heterogeneous fibrogladular tissue

d: Extreme fibrogladular tissue

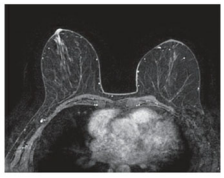


Figure 1 – AMOUNT OF FIBROGLANDULAR TISSUE: ALMOST ENTIRELY FAT. Fat-suppressed T1W image.

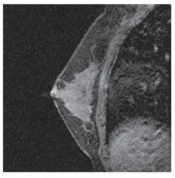


Figure 3 – AMOUNT OF FIBROGLANDULAR TISSUE: HETEROGENEOUS FIBROGLANDULAR TISSUE. Fat-suppressed T1W image.

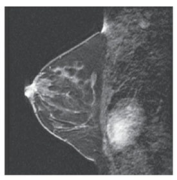


Figure 2 – AMOUNT OF FIBROGLANDULAR TISSUE: SCATTERED FIBROGLANDULAR TISSUE. Fat-suppressed T1W image.

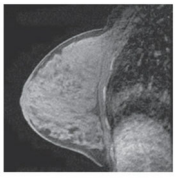


Figure 4 – AMOUNT OF FIBROGLANDULAR TISSUE: EXTREME FIBROGLANDULAR TISSUE. Fat-suppressed T1W image.

Background parenchymal enhancement (BPE)

- 今回の改定により記載することが明記された
- BPEに埋もれてしまう病変があることが前提
- BPEがあることを認識した上でBPEと区別されるものを異常ととらえて診断する
- 評価は，造影後約90秒後の画像で行う
- Asymmetricとなるものは，何らかの病理学的要因を反映していると考えられる
- 放射線治療後ではBPEが低下する

Level	Minimal
	Mild
	Moderate
	Marked

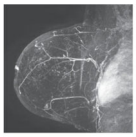


Figure 6 – LEVEL: MINIMAL BPE. Subtraction MIP. Fat-suppressed postcontrast T1W image.

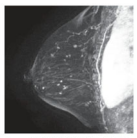


Figure 9 – LEVEL: MILD BPE. Subtraction MIP. Fat-suppressed postcontrast T1W image.

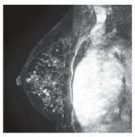


Figure 13 – LEVEL: MODERATE BPE. Subtraction MIP. Fat-suppressed postcontrast T1W image.

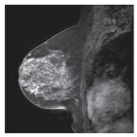


Figure 18 – LEVEL: MARKED BPE. First fat-suppressed postcontrast T1W image.

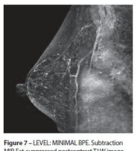


Figure 7 – LEVEL: MINIMAL BPE. Subtraction MIP. Fat-suppressed postcontrast T1W image.

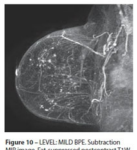


Figure 10 – LEVEL: MILD BPE. Subtraction MIP image. Fat-suppressed postcontrast T1W image.

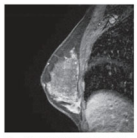


Figure 14 – LEVEL: MODERATE BPE. First fat-suppressed postcontrast T1W image.

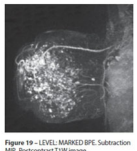


Figure 19 – LEVEL: MARKED BPE. Subtraction MIP. Postcontrast T1W image.

Symmetric or asymmetric	Symmetric
	Asymmetric

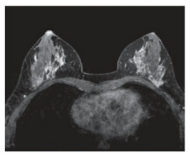


Figure 21 – SYMMETRIC OR ASYMMETRIC: SYMMETRIC. Moderate BPE. Fat-suppressed postcontrast T1W image.

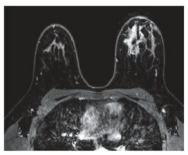


Figure 23 – SYMMETRIC OR ASYMMETRIC: ASYMMETRIC. Mastitis in the left breast causing increased enhancement. Fat-suppressed postcontrast T1W image.

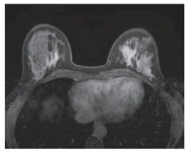


Figure 22 – SYMMETRIC OR ASYMMETRIC: SYMMETRIC. Moderate BPE. Fat-suppressed postcontrast T1W image.

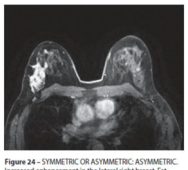
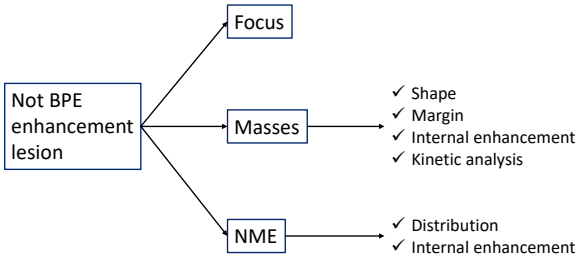


Figure 24 – SYMMETRIC OR ASYMMETRIC: ASYMMETRIC. Increased enhancement in the lateral right breast. Fat-suppressed postcontrast T1W image. Pathology: ductal carcinoma in situ (DCIS).

Focus, Masses, Non-mass enhancement (NME)



Focus

- BPEと区別される5mm以下の小造影効果
- 正常乳腺の一部や線維腺腫, 乳房内リンパ節などの小さな良性病変を想定
- まれに小さな浸潤癌などが含まれている場合があるため, 注意を要する

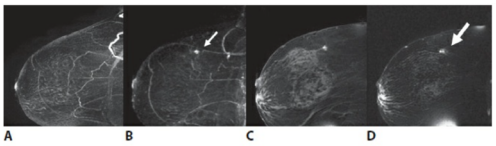
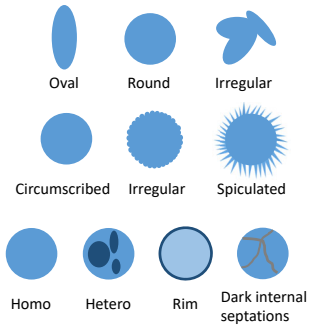


Figure 36 – FOCUS *(arrow)*. This is a new finding increasing suspicion. Also note only slightly high signal intensity of invasive cancer *(not cyst-like)* on T2W imaging *(thick arrow)*, adding to lesion suspicion. Prior 1-year MIP *(a)*; T1W imaging *(b)*; subtraction *(c)*; T2W imaging *(d)*.

Masses

- Shape(形状), Margin(辺縁), 内部の造影効果, Kinetic Analysis(造影パターン)の評価を行う

Shape	Oval
	Round
	Irregular
Margin	Circumscribed
	Not Circumscribed
	- Irregular
	- Spiculated
Internal enhancement characteristics	Homogeneous
	Heterogeneous
	Rim enhancement
	Dark internal septations



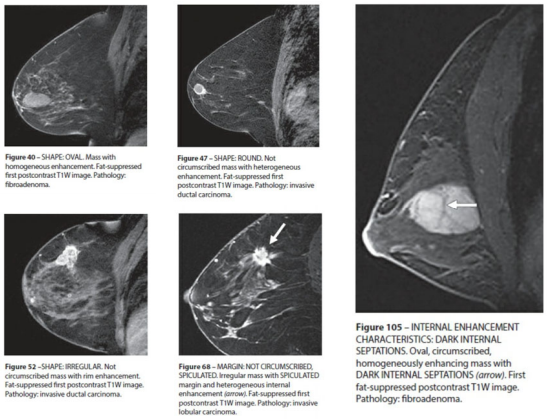


Figure 40 – SHAPE: OVAL. Mass with homogeneous enhancement. Fat-suppressed first postcontrast T1W image. Pathology: fibroadenoma.

Figure 47 – SHAPE: ROUND. Not circumscribed mass with heterogeneous enhancement. Fat-suppressed first postcontrast T1W image. Pathology: invasive ductal carcinoma.

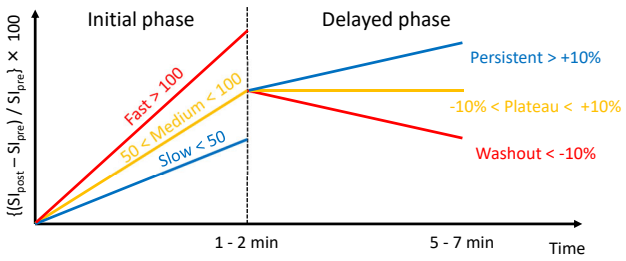
Figure 52 – SHAPE: IRREGULAR. Not circumscribed mass with rim enhancement. Fat-suppressed first postcontrast T1W image. Pathology: invasive ductal carcinoma.

Figure 68 – MARGIN: NOT CIRCUMSCRIBED, SPICULATED. Irregular mass with SPICULATED margin and heterogeneous internal enhancement *(arrow)*. Fat-suppressed first postcontrast T1W image. Pathology: invasive lobular carcinoma.

Figure 105 – INTERNAL ENHANCEMENT CHARACTERISTICS: DARK INTERNAL SEPTATIONS. Oval, circumscribed, homogeneously enhancing mass with DARK INTERNAL SEPTATIONS *(arrow)*. First fat-suppressed postcontrast T1W image. Pathology: fibroadenoma.

- ROIの設定は3ピクセル以上と定められており, 病変内部の最も悪性が疑われる領域に設定する

Kinetic curve assessment	Initial phase	Slow
		Medium
		Fast
	Delayed phase	Persistent
		Plateau
		Washout



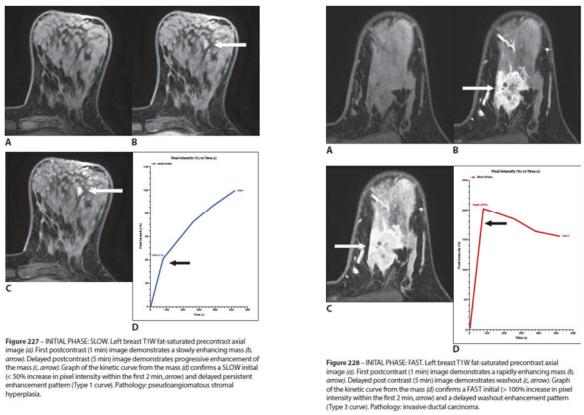
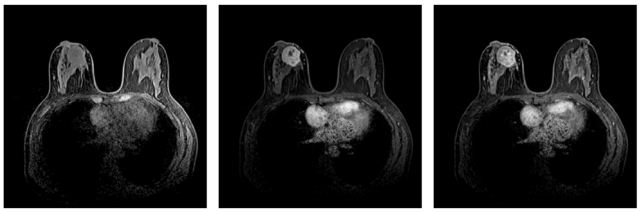


Figure 227 – INITIAL PHASE: SLOW. Left breast T1W fat-saturated precontrast axial image *(a)*. First postcontrast (1 min) image demonstrates a slowly enhancing mass *(b, arrow)*. Delayed postcontrast (5 min) image demonstrates progressive enhancement of the mass *(c, arrow)*. Graph of the kinetic curve from the mass *(d)* confirms a SLOW initial (< 50% increase in pixel intensity within the first 2 min, *arrow*) and delayed persistent enhancement pattern (Type 1 curve). Pathology: pseudoangiomatous stromal hyperplasia.

Figure 228 – INITIAL PHASE: FAST. Left breast T1W fat-saturated precontrast axial image *(a)*. First postcontrast (1 min) image demonstrates a rapidly enhancing mass *(b, arrow)*. Delayed post contrast (5 min) image demonstrates washout *(c, arrow)*. Graph of the kinetic curve from the mass *(d)* confirms a FAST initial (> 100% increase in pixel intensity within the first 2 min, *arrow*) and a delayed washout enhancement pattern (Type 3 curve). Pathology: invasive ductal carcinoma.

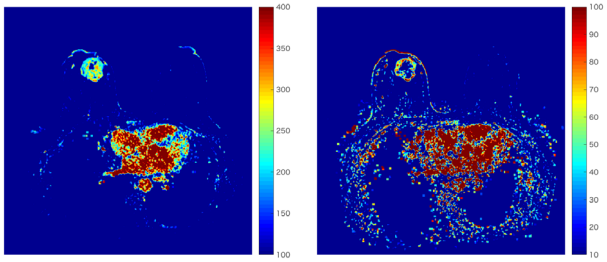
最も悪性が疑われる?

- 内部の造影効果が不均一な場合はROI設定に難儀
- Wash-outは何処?
- どの画像でROIを決定?



Pre　　Early　　Delay

Kinetic Maps

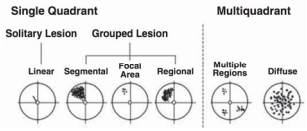


Wash-In Map　　Wash-Out Map

Non-mass enhancement (NME)

- Distribution(分布)と内部の造影効果で評価を行う
- DCISのkineticパターンは多彩であり, NMEの評価に有用となる科学的根拠はない

Distribution	Focal
	Linear
	Segmental
	Regional
	Multiple regions
	Diffuse
Internal enhancement patterns	Homogeneous
	Heterogeneous
	Clumped
	Clustered ring



clumped　　Clustered ring

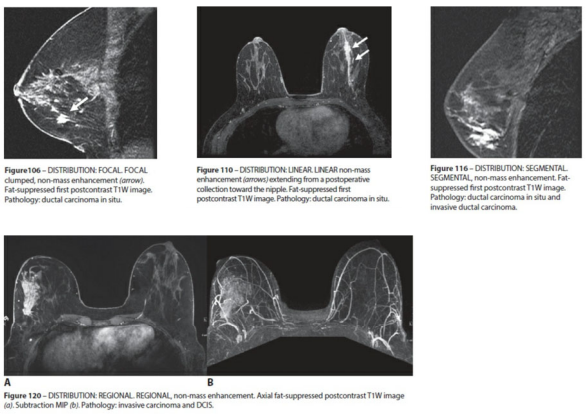


Figure106 – DISTRIBUTION: FOCAL. FOCAL clumped, non-mass enhancement (arrow). Fat-suppressed first postcontrast T1W image. Pathology: ductal carcinoma in situ.

Figure 110 – DISTRIBUTION: LINEAR. LINEAR non-mass enhancement (arrows) extending from a postoperative collection toward the nipple. Fat-suppressed first postcontrast T1W image. Pathology: ductal carcinoma in situ.

Figure 116 – DISTRIBUTION: SEGMENTAL. SEGMENTAL, non-mass enhancement. Fat-suppressed first postcontrast T1W image. Pathology: ductal carcinoma in situ and invasive ductal carcinoma.

Figure 120 – DISTRIBUTION: REGIONAL. REGIONAL, non-mass enhancement. Axial fat-suppressed postcontrast T1W image (a). Subtraction MIP (b). Pathology: invasive carcinoma and DCIS.

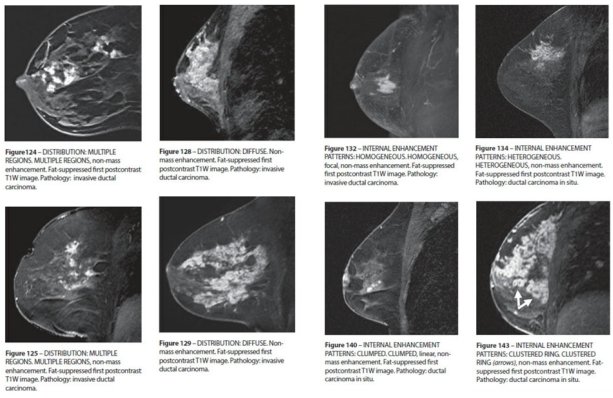


Figure124 – DISTRIBUTION: MULTIPLE REGIONS. MULTIPLE REGIONS, non-mass enhancement. Fat-suppressed first postcontrast T1W image. Pathology: invasive ductal carcinoma.

Figure 128 – DISTRIBUTION: DIFFUSE. Non-mass enhancement. Fat-suppressed first postcontrast T1W image. Pathology: invasive ductal carcinoma.

Figure 132 – INTERNAL ENHANCEMENT PATTERNS: HOMOGENEOUS. HOMOGENEOUS, focal, non-mass enhancement. Fat-suppressed first postcontrast T1W image. Pathology: invasive ductal carcinoma.

Figure 134 – INTERNAL ENHANCEMENT PATTERNS: HETEROGENEOUS. HETEROGENEOUS, non-mass enhancement. Fat-suppressed first postcontrast T1W image. Pathology: ductal carcinoma in situ.

Figure 125 – DISTRIBUTION: MULTIPLE REGIONS. MULTIPLE REGIONS, non-mass enhancement. Fat-suppressed first postcontrast T1W image. Pathology: invasive ductal carcinoma.

Figure 129 – DISTRIBUTION: DIFFUSE. Non-mass enhancement. Fat-suppressed first postcontrast T1W image. Pathology: invasive ductal carcinoma.

Figure 140 – INTERNAL ENHANCEMENT PATTERNS: CLUMPED. CLUMPED, linear, non-mass enhancement. Fat-suppressed first postcontrast T1W image. Pathology: ductal carcinoma in situ.

Figure 143 – INTERNAL ENHANCEMENT PATTERNS: CLUSTERED RING. CLUSTERED RING (arrows), non-mass enhancement. Fat-suppressed first postcontrast T1W image. Pathology: ductal carcinoma in situ.

Implant (Silicone)

Implantの評価には通常の撮像シーケンスに加え,

➢**Silicone excitation image**

を撮像することにより, シリコンの被膜の観察が容易

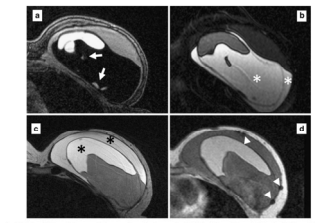


Fig. 12 MRI of a 54-year-old woman with a ruptured breast implant confirmed at surgery. a Axial silicone suppression. b Axial silicone-excited sequence. c Axial T2-weighted turbo spin echo. d Axial T1-weighted turbo spin echo. Silicone gel (*white asterisks*) inside and outside the implant. A moderate amount of water and probably serum is mixed in the silicone gel around the implant (*black asterisks*). Note also the punctate changes in signal intensity—droplets within the implant (*arrows*) and punctuate and hyperintense images due to calcifications in the implant periphery (*arrowheads*)

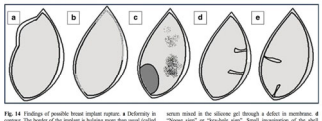
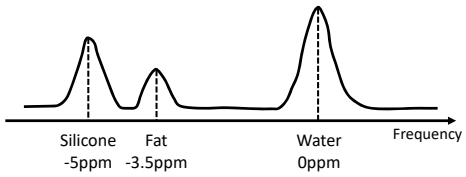


Fig. 14 Findings of possible breast implant rupture. a Deformity in contour. The border of the implant is bulging more than usual (called the "rat-tail sign" when very pronounced). Sometimes rupture cannot be differentiated from herniation. b Irregular margin. The border of the implant is blurry. Frequently seen with calcification of the fibrous capsule. c Changes in the signal intensity of the silicone gel. Water/serum mixed in the silicone gel through a defect in membrane. d "Noose sign" or "key-hole sign". Small invagination of the shell where the two membranes do not touch. e "Teardrop sign". Invagination of the shell containing a droplet of silicone. The last two images represent silicone gel leakage through a small focal implant shell tear

S. Juanpere, Insights Imaging (2011)

Silicone excitation image?

- 周波数選択的な脂肪抑制では, 脂肪とシリコンの周波数が近く, どちらも抑制され低信号となるため, 脂肪抑制はSTIRを使用する
- 水信号を抑制するため, Water Saturationパルスを印可する

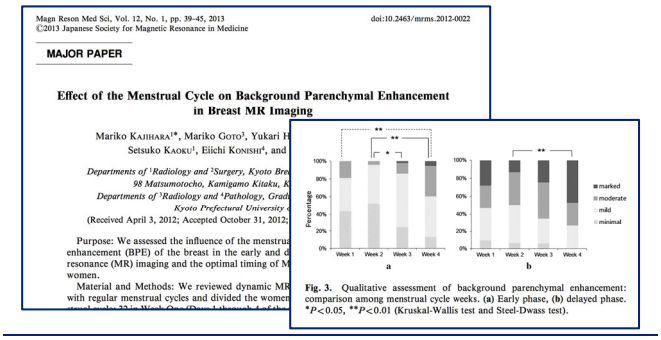


推奨プロトコル (EUSOBI+ACR+JABCS)

- 至適撮像時期：月経開始後 7–14 (5-12)日後
- 静磁場強度：1.5 or 3T
- 体位：腹臥位
- 使用コイル：乳房専用コイル
- 撮像シーケンス
  - 脂肪抑制T2WI (CHESS or STIR)
  - T1WI (脂肪抑制なし)
  - DWI
  - Dynamic (1-2分の時間分解能でTime Intensity Curveの計測には少なくとも3回撮像する)
- 撮像断面は適宜. ただし, Dynamicは両側含める

Scheduling

月経開始後 7-14 (5-12)日後に施行することが勧められる. (ただし, ステージング目的の場合にはこの限りではない)


Magn Reson Med Sci, Vol. 12, No. 1, pp. 39–45, 2013 doi:10.2463/mrms.2012-0022
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MAJOR PAPER

Effect of the Menstrual Cycle on Background Parenchymal Enhancement in Breast MR Imaging

Mariko KAJIHARA[1]*, Mariko GOTO[3], Yukari H
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*Departments of [1]Radiology and [2]Surgery, Kyoto Bre
98 Matsumotocho, Kamigamo Kitaku, K
Departments of [3]Radiology and [4]Pathology, Gradu
Kyoto Prefectural University*

(Received April 3, 2012; Accepted October 31, 2012;

Purpose: We assessed the influence of the menstrua
enhancement (BPE) of the breast in the early and d
resonance (MR) imaging and the optimal timing of M
women.

Material and Methods: We reviewed dynamic MR
with regular menstrual cycles and divided the women

Fig. 3. Qualitative assessment of background parenchymal enhancement: comparison among menstrual cycle weeks. **(a)** Early phase, **(b)** delayed phase. $^{*}P<0.05$, $^{**}P<0.01$ (Kruskal-Wallis test and Steel-Dwass test).

Technique / Procedure

静磁場強度：1.5 or 3T

➢1.5 or 3T ?

- 3Tは1.5Tに比べてSNRや傾斜磁場性能が高いため, 同じ撮像時間でもより高空間分解能化が可能
- 3Tの方がB_0, B_1不均一の影響を受けやすく, 脂肪抑制, 信号ムラが1.5Tに比べて顕著

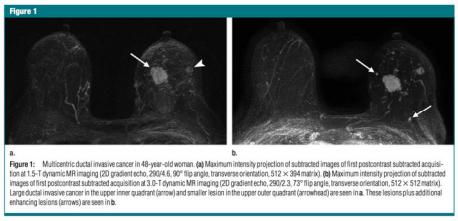


Figure 1

a b

Figure 1: Multicentric ductal invasive cancer in 48-year-old woman. **(a)** Maximum-intensity projection of subtracted images of first postcontrast subtracted acquisition at 1.5-T dynamic MR imaging (2D gradient echo, 290/4.6, 90° flip angle, transverse orientation, 512 × 394 matrix). **(b)** Maximum-intensity projection of subtracted images of first postcontrast subtracted acquisition at 3.0-T dynamic MR imaging (2D gradient echo, 290/2.3, 73° flip angle, transverse orientation, 512 × 512 matrix). Large ductal invasive cancer in the upper inner quadrant (arrow) and smaller lesion in the upper outer quadrant (arrowhead) are seen in **a**. These lesions plus additional enhancing lesions (arrows) are seen in **b**.

Kuhl, Radiology, 2009

Technique / Procedure

使用コイル：乳房専用コイル

体位：腹臥位 (コイルの端に乳房を挟まないように注意)


Positioning in Breast MR Imaging to Optimize Image Quality[1]

BREAST IMAGING

Figure 2. Guiding the patient into the coil. As the patient positions herself in the coil, the technologist's hand over the patient's back guides the patient into the coil while the other hand smooths out inferior breast skin folds by pulling downward toward the patient's feet (arrow), maintaining tension as the breast drops into the coil.

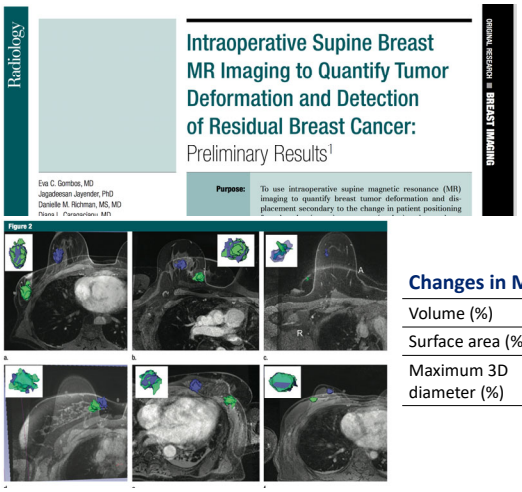
腹臥位が良いのか?

腹臥位の利点

- 乳腺が進展するため, 乳管内成分の描出が向上
- 体動が少ない
- 専用コイルを使用すれば, SNRが高く, 両側同時に高分解能画像が取得可能

欠点

- 手術体位との乖離 ⇨ 腫瘍の変形やサイズ変化


Radiology

Intraoperative Supine Breast MR Imaging to Quantify Tumor Deformation and Detection of Residual Breast Cancer: Preliminary Results[1]

ORIGINAL RESEARCH ■ BREAST IMAGING

Eva C. Gombos, MD
Jagadeesan Jayender, PhD
Danielle M. Richman, MS, MD

Purpose: To use intraoperative supine magnetic resonance (MR) imaging to quantify breast tumor deformation and displacement secondary to the change in patient positioning

Figure 2

Changes in MRI

Volume (%)	23.8 ± 49.9
Surface area (%)	6.5 ± 29.2
Maximum 3D diameter (%)	-7.1 ± 25.7

Image Plane ?

矢状断

- FOVを絞れるため, 高空間分解能の撮像が可能
- FOV内の磁場の均一性が良く, 脂肪抑制が良好
- マンモグラフィのMLOと比較が容易
- 両側撮像では撮像枚数が多くなるため, 不向き

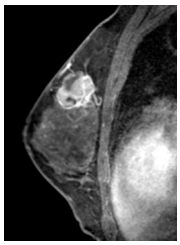


Image Plane ?

冠状断

- 呼吸によるアーチファクトを受けやすい
- 両側撮像に向き, 左右比較が容易
- 撮像領域が広く, 横方向の広がりの把握が容易

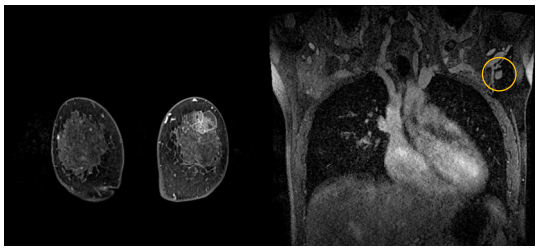


Image Plane ?

横断

- 乳管に沿う広がりの把握が容易
- マンモグラフィのCCとの比較が容易
- 両側撮像に向き, 左右比較が容易

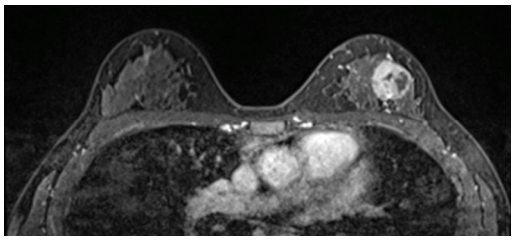


Image Plane ?

ダイナミックは両側撮像が基本!

➢BPEの評価, 対側病変の検出のため

撮像断面は**横断** or **冠状断**
ただし, 乳房MRIの読影は形態評価が中心であるため, **高空間分解能（高マトリクス）の撮像が必須**
ガイドラインでは1mm以下の面内分解能を推奨

ダイナミック以外のシーケンス

➢各施設で適宜選択

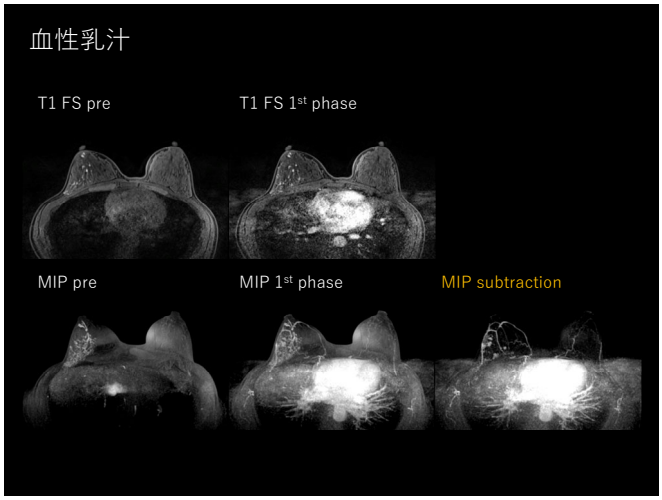
Active or Passive Fat Suppression?

Active Fat Suppression

- CHESS, SPAIR, Water excitation等のRFパルス を用いた選択的脂肪抑制法
- 脂肪抑制に時間を要する
- 磁場の不均一に弱い

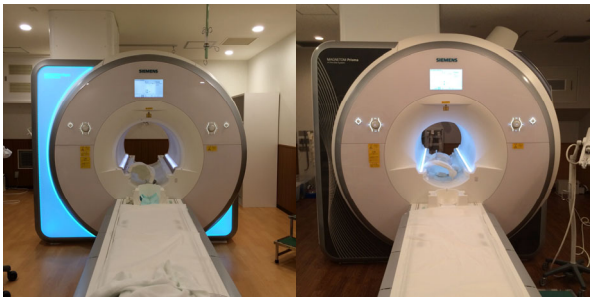
Passive Fat Suppression

- Subtraction法
- 脂肪抑制の時間を省略できるため, 撮像時間が短縮
- 体動に弱い
- 脂肪抑制不良症例ではSubtractionを推奨
- TEはin phaseに設定する（Paradoxical suppression）
- 造影前に脂肪抑制T1強調画像で高信号を示す病変の信号を消すために有用



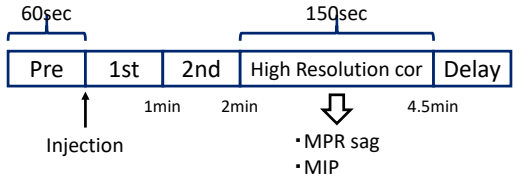
京大プロトコル

MRI装置：MAGNETOM Skyra, Prisma fit (3T)
コイル：Dedicated 18ch Breast coil



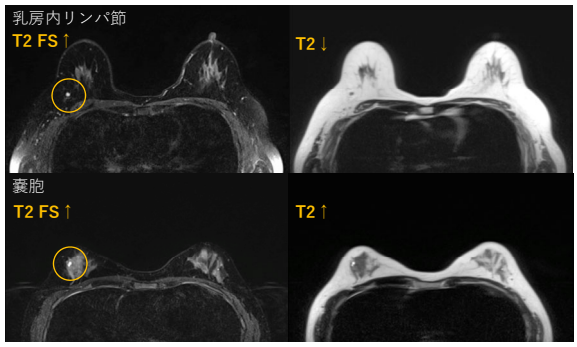
京大プロトコル

1. T2WI FS axi
2. HASTE axi
3. T1WI noFS axi (dual FA GRE, T1 Map)
4. DWI axi { High Reso DWI (RESOLVE) sag }
5. Dynamic FS axi



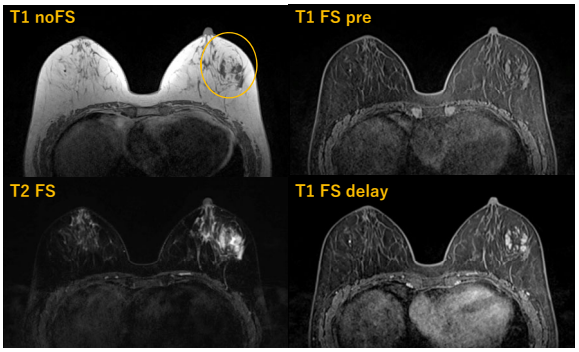
T2WI FS and noFS

- T2高信号病変の鑑別



T1 noFS

- 過誤種



乳房MRIにおけるピットホール

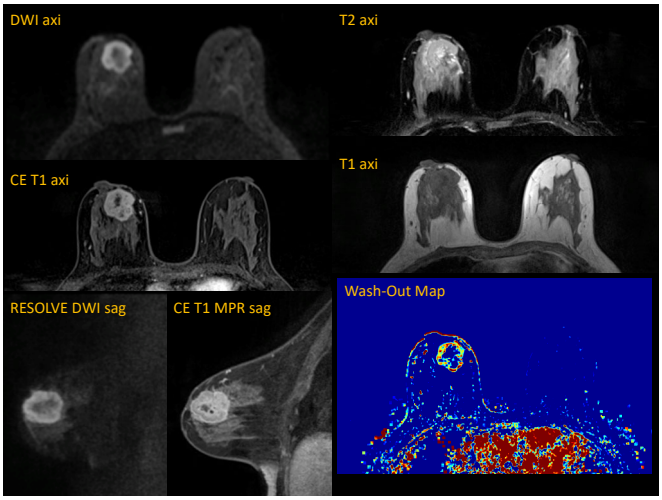
- 標準化された撮像法がない
  - ➢静磁場強度, 装置スペック, ベンダー間の得手/不得手の問題
- 造影剤が使えない症例(アレルギー, 腎機能低下)
- BPEに埋もれてしまう病変の検出限界
- 高い偽陽性

造影剤が使えない症例に対して

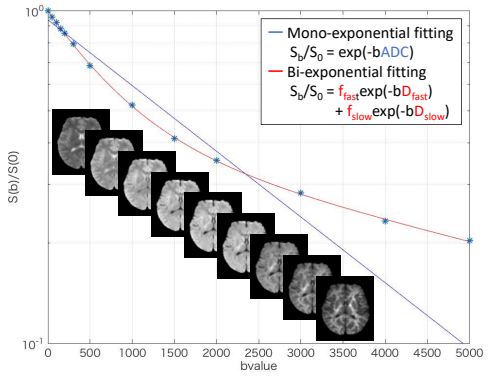
乳癌検診MRIガイドライン

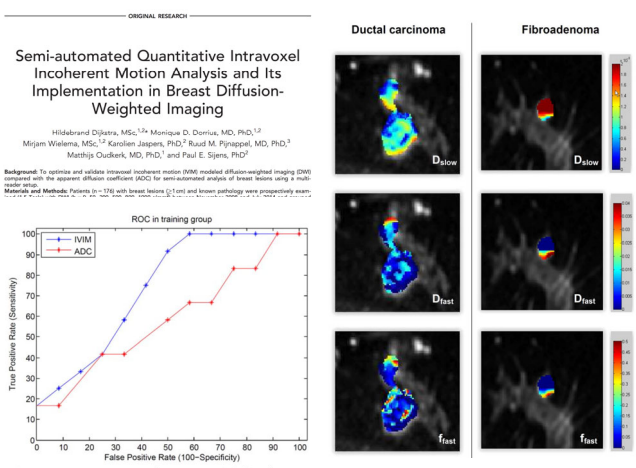
●拡散強調画像の撮像は勧められるか?
- ✓推奨グレード C1 科学的根拠はないが撮像は推奨
- ✓感度は比較的高く, 検出に際して有用性は高い
- ✓解像度は低く, アーチファクト, 歪みも強い
- ✓ADC値による良悪性の鑑別は可能であるが, 重なりが あり, 限界が見られる

●拡散強調画像を含めた非造影MRIによる乳房MRI スクリーニングは勧められるか?
- ✓推奨グレード C2 科学的根拠はなく, 行わないよう 勧められる



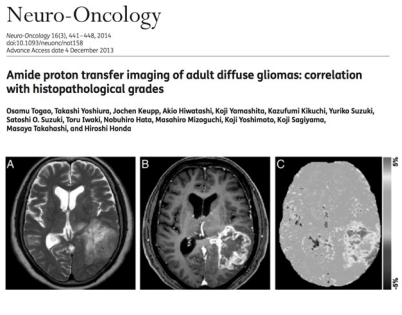
IntraVoxel Incoherent Motion (IVIM)

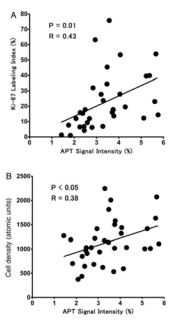




造影剤が使えない症例に対して

CEST Imaging





A New Contrast in MR Mammography by Means of Chemical Exchange Saturation Transfer (CEST) Imaging at 3 Tesla: Preliminary Results

Ein neuer Kontrast in der MR-Mammografie durch Chemical-Exchange-Saturation-Transfer(CEST)-Bildgebung bei 3 Tesla: erste Ergebnisse

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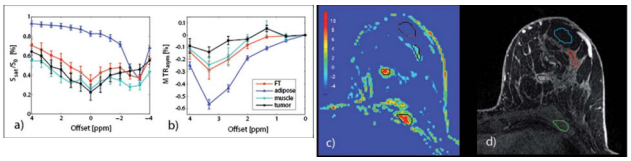


BPEに埋もれてしまう病変

さらに高空間分解能, 高時間分可能を目指す

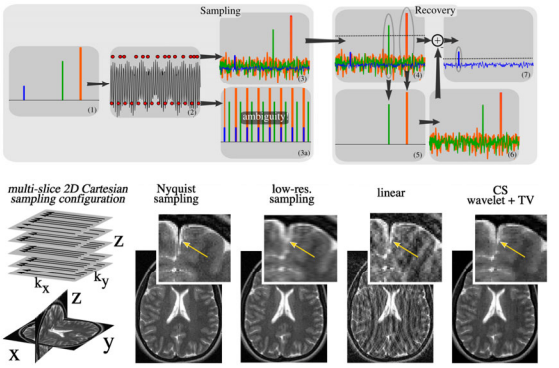
✓Key-hole Imaging

✓KWIC

✓Compressed Sensing

➡
- 今まで見えなかったものを見る
- Quantitative Kinetic Analysis

Compressed Sensing MRI



Donoho D. IEEE 2006

欧州におけるMRIを用いた乳房スクリーニング

マンモグラフィによる乳房スクリーニングの問題点
- Over-diagnosis
- Under-diagnosis

乳房スクリーニングで大事なこと

➢すべての病変を見つけるのではなく,
治療を要する病変のみを検出する

‖

造影MRIで検出できる病変

➢血管新生, プロテアーゼ活性を反映したもの

MRIによる乳房スクリーニングの問題点

- 高価
- 検査時間
- 読影
- 造影剤

MRIによる乳房スクリーニング

VOLUME 32 · NUMBER 22 · AUGUST 1 2014
JOURNAL OF CLINICAL ONCOLOGY ORIGINAL REPORT

Abbreviated Breast Magnetic Resonance Imaging (MRI): First Postcontrast Subtracted Images and Maximum-Intensity Projection—A Novel Approach to Breast Cancer Screening With MRI

Christiane K. Kuhl, Simone Schrading, Kevin Strobel, Hans H. Schild, Ralf-Dieter Hilgers, and Heribert B. Bieling

See accompanying editorial on page 2281

Christiane K. Kuhl, Simone Schrading, Kevin Strobel, Ralf-Dieter Hilgers, and Heribert B. Bieling, University Hospital of Aachen, Rheinisch-Westfälische Technische Hochschule, Aachen; and Hans H. Schild, University of Bonn, Bonn, Germany.

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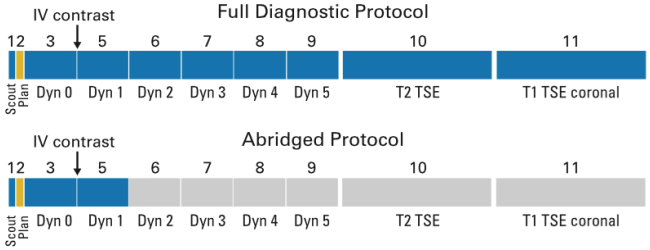
Authors' disclosures of potential conflicts of interest and author contributions are found at the end of this

ABSTRACT

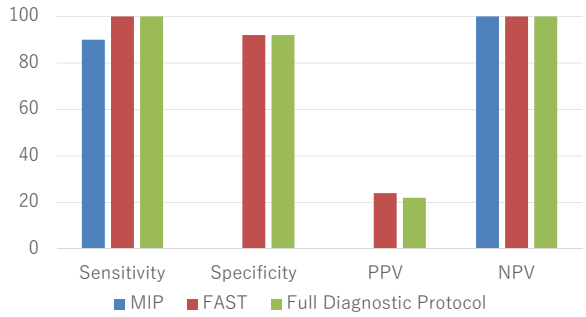
Purpose
We investigated whether an abbreviated protocol (AP), consisting of only one pre- and one postcontrast acquisition and their derived images (first postcontrast subtracted [FAST] and maximum-intensity projection [MIP] images), was suitable for breast magnetic resonance imaging (MRI) screening.

Methods
We conducted a prospective observational reader study in 443 women at mildly to moderately increased risk who underwent 606 screening MRIs. Eligible women had normal or benign digital mammograms and for those with heterogeneously dense or extremely dense breasts (n = 427)

Concept of Abbreviated MRI



Results:
Diagnostic accuracy of MIP, FAST, and Full Protocol



Abbreviated Breast MRI for screening

AB-MRI may be the ideal screening tool for women:

- Conceivable to conduct on a population-wide scale
- High sensitivity for biologically relevant cancers, over 10-fold higher added cancer yield compared to DBT
- High diagnostic accuracy → PPV equivalent to that of Digital Mammo
- No breast compression, no radiation involved.

最後に

Positioning in Breast MR Imaging

Use of Dedicated Breast MR Imaging Technologists

Dedicated breast MR imaging technologists, either with prior mammography technologist experience or a strong interest in breast imaging, are more likely to be successful in obtaining consistent and optimal breast MR images. Trained motivated technologists are more likely to pay attention to details, ask pertinent questions, and understand the patient issues that can affect positioning. Dedicated breast MR imaging technologists will benefit from the high volume of breast-specific experience. Owing to the similarities in positioning for

Teaching Point