BREAST MRI

PROTOCOL UPDATES

- Optimize scan times
  - Enhance patient satisfaction
- Improve image quality
  - Positioning
  - Common Artifacts and how to fix them
- Prepare for increased Breast MRI volume

“ Simplicity is the ultimate sophistication”

Leonardo DaVinci

“ Do the best you can until you know better. Then when you know better, do better”

Maya Angelou

OPTIMIZE SCAN TIME (SIMPLIFY)

- Protocols will now be on ROI's website for easy access
  - All updated protocols should be immediately built in all scanners
  - What are the major changes?

ACR BREAST MRI ACCREDITATION

Breast Image Quality Criteria

Required Sequences	Category A: Pulse Sequence and Image Contrast	Category B: Positioning and Anatomic Coverage	Category C: Spatial and Temporal Resolution
T2 - Weighted/Bright Fluid Series*	• Adequate SNR/not too grainy • Sufficient bright fluid contrast	• Adequate breast tissue inside coil • Breast properly positioned within coil • Properly positioned nipple • Image set covers both breasts, from axillary tails to inframammary folds • Minimal or no skin folds	N/A
Multi-Phase T1 Weighted Series**			
Pre-Contrast T1	• Adequate SNR/not too grainy		• Slice thickness ≤ 3 mm • Gap ≤ 0 mm • In-plane pixel (phase) ≤ 1 mm • In-plane pixel (frequency) ≤ 1 mm • Early phase post-contrast T1-weighted series completed within
Early Phase Post-Contrast T1	• Adequate SNR/not too grainy • If fat suppression is not evident, subtracted and un-subtracted images also must be provided		
Delayed Phase Post-Contrast T1			
	• Technical factors match pre-contrast T1 • IV contrast is evident		4 minutes of the end of the contrast injection. Do not include the time for saline flush in this value.

PEAK PHASE OF ENHANCEMENT

-It is essential to obtain an image approximately 60-120 seconds after contrast material administration, as most breast cancers will show peak enhancement at that time.
Breast MRI: State of the Art. Published Online: Jul 30 2019 https://doi.org/10.1148/radiol.2019182947

- …tumor enhancement peaks early (1-2 minutes), tumor conspicuity diminishes as tissue washes in during delayed phases
Abbreviated and Ultrafast Breast MRI in Clinical Practice September 18, 2020
https://pubs.rsna.org/radiographics/doi/10.1148/rg.2020200006

-"It is important to obtain the peak contrast sequence at 60-120 seconds post contrast administration" Breast MRI: A CASE-BASED REVIEW OF ESSENTIALS AND ENHANCEMENTS COURSE. Wendy DeMartini, MD FSBI, Division Chief, Breast Imaging Professor, Department of Radiology at Stanford University School of Medicine

PEAK PHASE OF ENHANCEMENT

-Inject contrast then wait 30 seconds
- Each dynamic scan is ~ 90 seconds
- Time 1 post contrast begins at around 30 sec – 2 min **peak phase falls here**
- Time 2 post contrast begins at around 2 min – 3 min 30 sec
- Time 3 post contrast begins at around 3 min 30 sec – 5 min
- Time 4 post contrast begins at around 5 min – 6 min 30 sec

Abbreviated Protocol
-Inject contrast then wait 2 min which is NOT in the peak phase
- Should wait 30 sec vs 60 sec then scan
* see next slide

DISCUSSION POINTS

Value-Based Acquisition Techniques lecture: Wendy DeMartini, MD(Stanford University School of Medicine) has started doing the T2 weighted sequence at the end of protocol.

- Did not find a significant difference in T2 signal intensity after contrast administration
- Helps decrease patient motion on the contrast series due to fatigue

Value-Based Acquisition Techniques lecture: Lars Grimm, MD(Duke University School of Medicine) shifts the post contrast Abbreviated time point by 30 sec(1.25 pass).

- Can help if there is a concern if the patient has some delayed cardiac output or there is a problem with the injection so as to not miss that peak phase of enhancement of 60 sec-120 sec since we are only obtaining 1 pass.

?????? Your thoughts

ROUTINE BREAST MRI

Current Protocol

LOC

STIR TRAN

SPACE 3D FS

T1 TRAN NON FS

T1 TRAN FS PRE DYN

T1 TRANS FS POST DYN SERIES

T1 TRANS FS DELAYED

New Protocol

LOC

SPACE 3D FS

T1 TRAN NON FS

T1 TRAN FS PRE DYN

T1 TRANS FS POST DYN SERIES

IMPLANT INTEGRITY PLUS CONTRAST

(CANCER SCREENING)

Current Protocol	New Protocol
LOC	LOC
STIR TRAN	SPACE 3D FS
SPACE 3D FS	STIR TRAN WATER SAT
STIR TRAN WATER SAT	T1 TRAN NON FS
T1 TRAN NON FS	T1 TRAN FS PRE DYN
T1 TRAN FS PRE DYN	T1 TRANS FS POST DYN
T1 TRANS FS POST DYN	TRIM-WS-SAG-SILICONE LEFT
T1 TRANS FS DELAYED	TRIM-WS-SAG-SILICONE RIGHT
TRIM-WS-SAG-SILICONE LEFT	
TRIM-WS-SAG-SILICONE RIGHT	

IMPLANT INTEGRITY

(WITHOUT CONTRAST)

Current Protocol –No Change

LOC

STIR TRAN

STIR TRAN WATER SAT

T1 TRAN NON FS

TIRM-WS-SAG-SILICONE LEFT

TIRM-WS-SAG-SILICONE RIGHT

IF THE PATIENT HAS NO OTHER BREAST COMPLAINTS. VERY COMMON TO USE

For silicone implants the FDA recommends an US or MRI 5-6 years after the implants are placed and every 2-3 years thereafter to monitor for asymptomatic silent rupture. MRI is the most sensitive exam for detecting silicone implant rupture. 2022 FDA Breast Implant Guidance

LOC

SPACE 3D FS

T1 TRAN FS PRE DYN

T1 TRAN FS POST DYN

ABBREVIATED MRI(ABRMI)

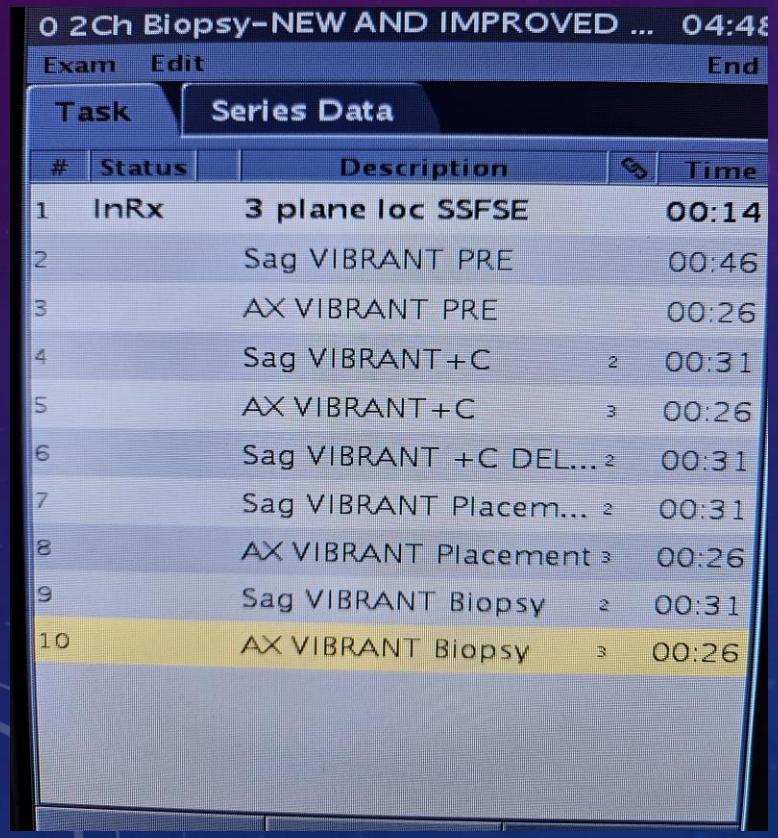
BIOPSY SAGITTAL

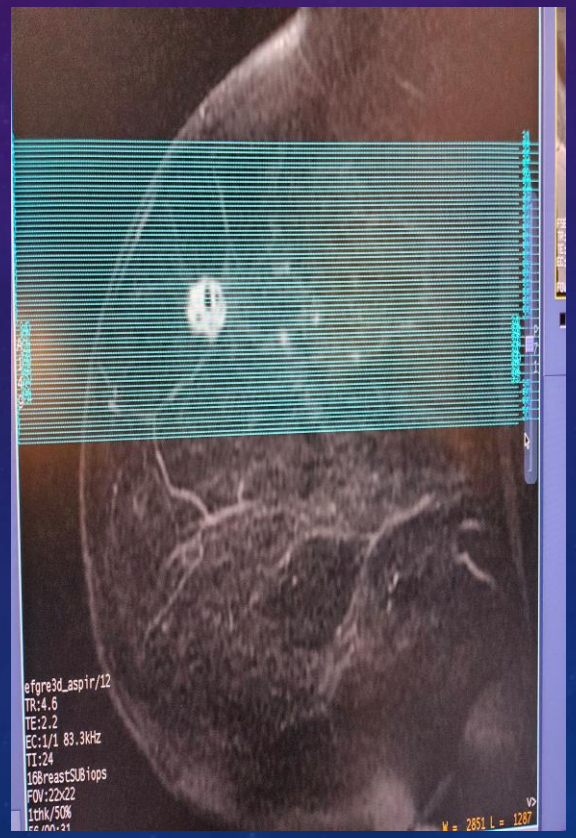
Current Protocol

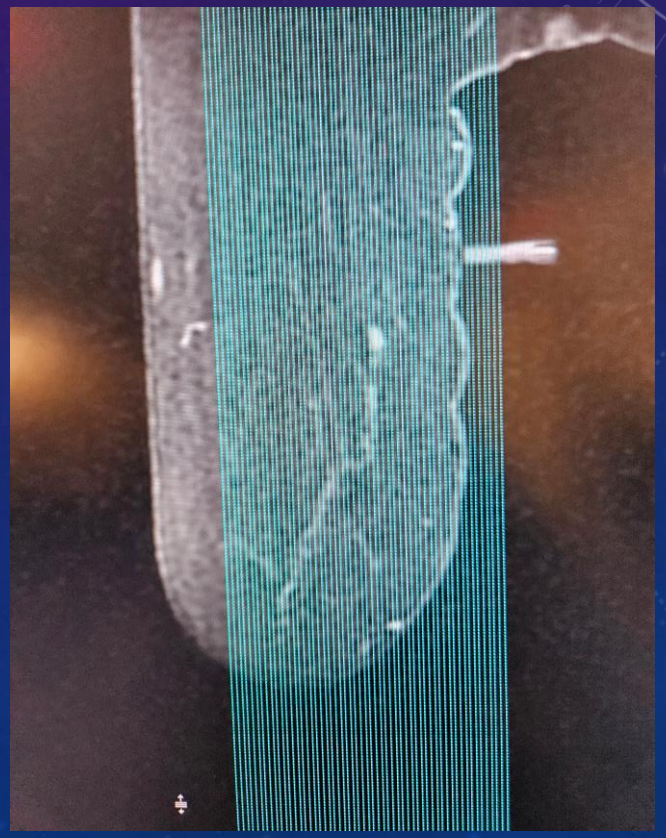
	Time
LOC	
T1 DYN SAG FS PRE	1:25
T1 DYN SAG FS POST	1:25
T1 DYN SAG Obturator	1:25
T1 DYN SAG post bx	1:25
T1 DYN AX Thin	1:25

BIOPSY AXIAL

Some rads prefer to do axial scanning. We are working on a protocol. Below is Community South's protocol:







POST MR BIOPSY CLIP MIGRATION

-Manual aspiration to evacuate any hematoma/fluid prior to clip

-SecurMark clips-minimize movement in the biopsy cavity with the bio-absorbable suture-like net

- 3 shapes for MRI : Buckle, Infinity, Stoplight

-Discussing: Hold lateral compression in prone position to stop bleeding

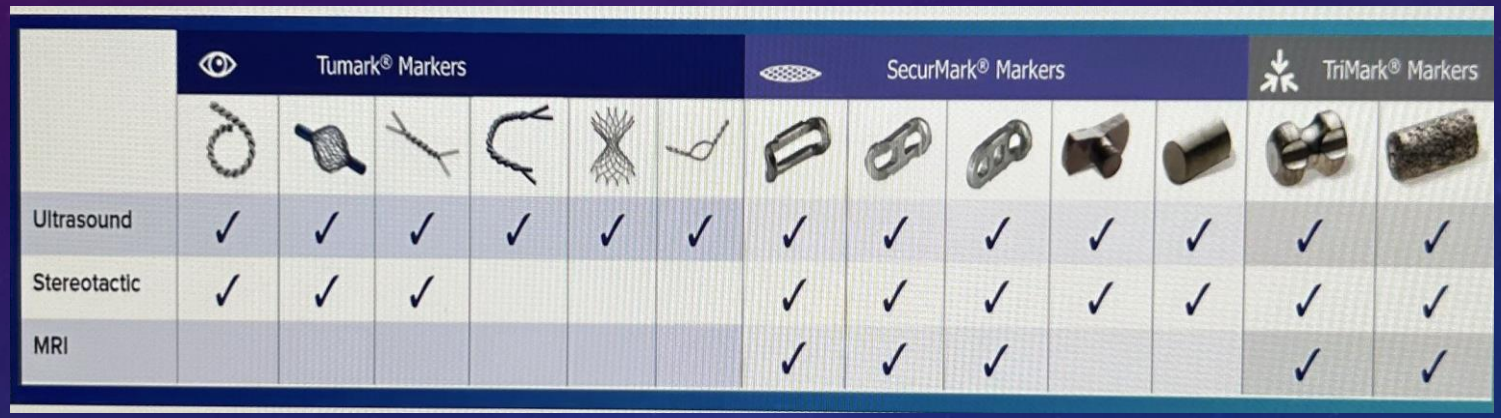
- allow patient to move arms down or move head as needed to improve comfort while holding compression

-When patient gets up maintain compression in similar fashion as in a full lateral mammogram position

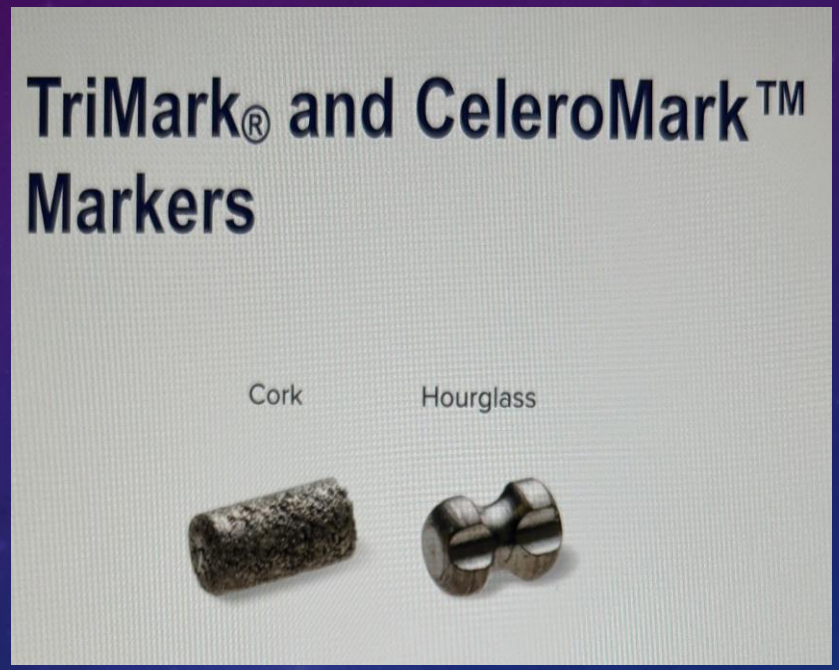
-Incorrect compression can displace the clip out of the biopsy cavity and induce the "accordion effect"

- Accordion effect occurs when the clip is displaced away from the biopsy cavity in the Z-axis. When compression is released the clip can migrate far from biopsy site

MRI BIOPSY CLIPS



MRI BIOPSY CLIPS



TriMark clips for more superficial lesions

SecurMark clips for all other lesions to minimize clip migration with suture like net

IMPROVE IMAGE QUALITY

- Position…Position…Position!
  - Free-hanging breasts
  - Maximize area of breast tissue imaged
    - Coverage of the entire breast from the axillary tail to the inframammary fold
    - Required for ACR accreditation
  - Nipple centered without rotation
  - Minimize skin folds
  - Stabilization, but no significant deformation of the breast
  - Achieve homogeneous fat suppression across entire breast volume

POSITIONING REFRESHER

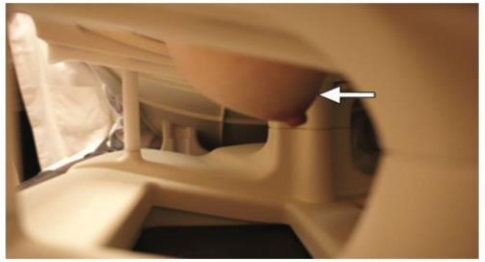


Figure 4. Top-down view. View from the top of the coil, from the patient's head down toward the patient's feet, shows that the breast is pointing medially (arrow) when viewed from the top down. The breast can appear well positioned from the lateral view but may actually be pointing medially when viewed from the top down.

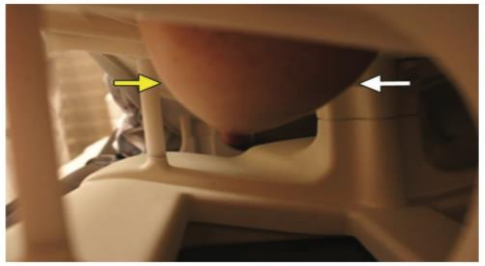


Figure 5. Properly positioned breast from the top-down view. White arrow = medial breast, yellow arrow = lateral breast.

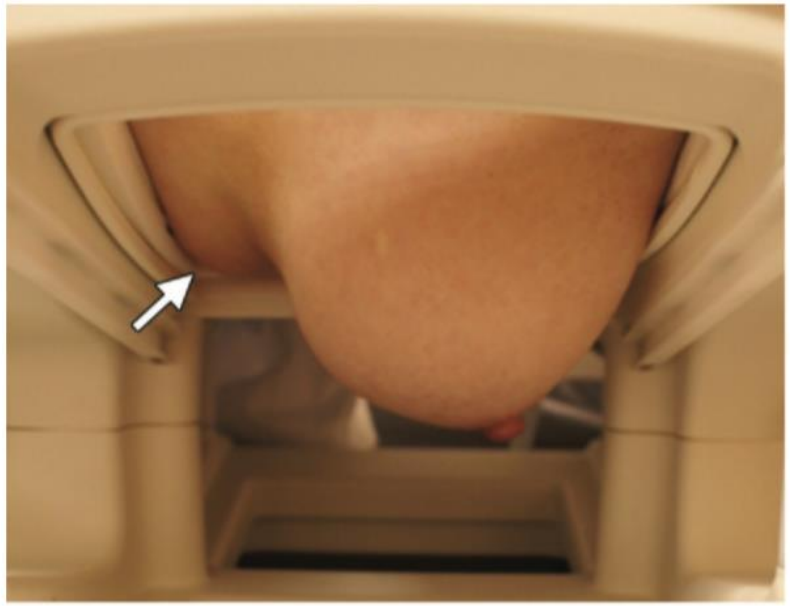
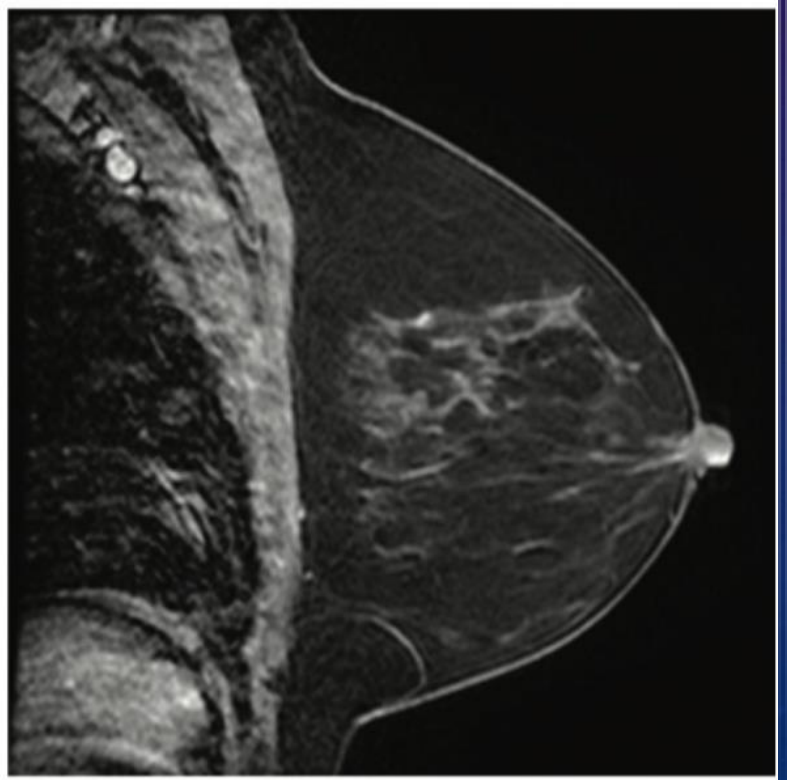


Figure 6. Poor superior positioning. **(a)** Lateral view shows the breast positioned too far superiorly in the coil with too much inferior abdominal tissue (arrow). The patient's head is toward the right side of the image and the patient's feet are toward the left side of the image. **(b)** Sagittal postcontrast MR image shows artifact from poor fat saturation (arrow) due to decoupling superiorly. This is a result of positioning too far superiorly in the coil. **(c)** Sagittal postcontrast MR image, obtained with the breast optimally positioned and centered in the coil, shows homogeneous fat suppression with no decoupling superiorly.

a.



POOR SUPERIOR POSITIONING

- Decoupling mechanism can occur
  - Local distortion of the transmit field and signal intensity if too much pressure is put on the coil in one specific area
  - How to fix it
    - Move patient into proper position
    - Sometimes thin padding between the body part and the coil can help

POOR MEDIAL POSITIONING

- The breasts should be freely hanging in the coil
- Nipples straight down
  - Use top-down view to ensure nipples are not pointed medially
  - Pull medial tissue out from sternum, down or out.
  - Always check triplane localizer and reposition as needed

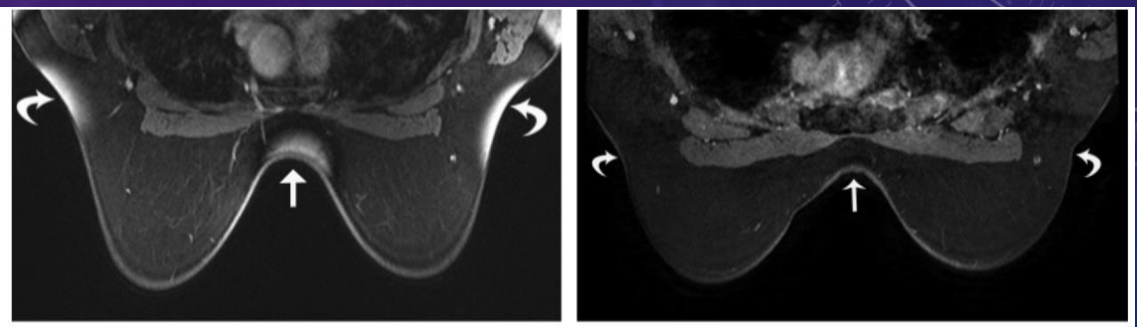


Figure 7. Poor fat suppression. **(a)** Axial postcontrast dynamic T1-weighted MR image of the bilateral breasts shows poor fat suppression laterally (curved arrows) and medially (straight arrow) as a result of poor positioning. **(b)** Corresponding image, obtained during repeat imaging with the patient centered in the coil, shows homogeneous fat suppression laterally (curved arrows) and medially (straight arrow).

INFERIOR BULGE

Lift the patient pulling breast tissue up into the coil and abdominal tissue down out of the coil

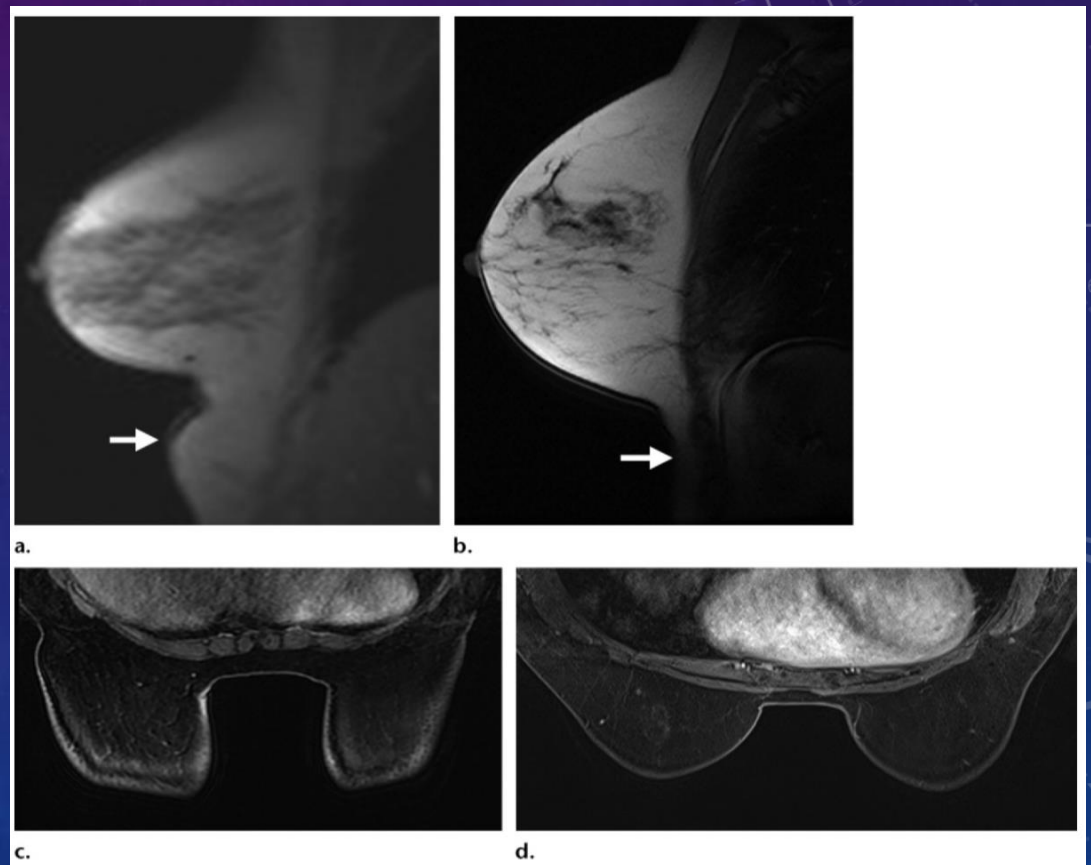


Figure 13. Inferior bulge. **(a)** Sagittal triplane localizer image shows an inferior bulge (arrow), which causes inhomogeneous fat suppression inferiorly. **(b)** Corresponding image after repositioning shows resolution of the bulge (arrow). If an inferior bulge is noted on a sagittal triplane localizer image, the solution is to lift and roll the patient, pulling breast tissue up into the coil and abdominal tissue down out of the coil. **(c)** Axial postcontrast dynamic T1-weighted MR image shows inhomogeneous fat saturation inferiorly as a result of an inferior bulge. **(d)** Corresponding image after repositioning with removal of the bulge shows homogeneous fat suppression inferiorly.

LARGE BREASTS

- Bilateral areas of compression against the coil causes inhomogenous fat suppression
- Anterior puddling may cause inhomogeneous inflow of contrast material
  - There should be consistent inflow of contrast throughout the breast tissues. Breast tissues compressed against the coil may decrease blood flow potentially causing nonenhancement of a malignancy

•Fix: Place a pad on the coil underneath the sternum or underneath abdomen so that the breasts hang freely, tuning the shim(usually automatic)

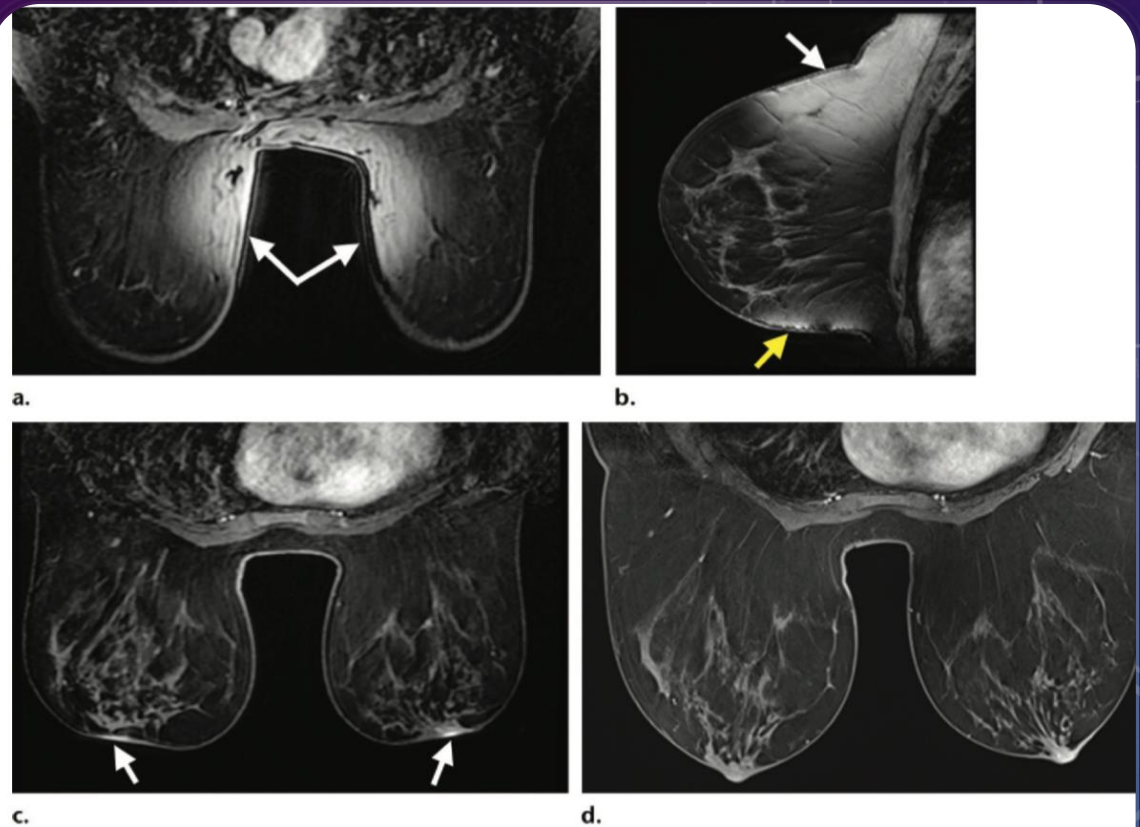
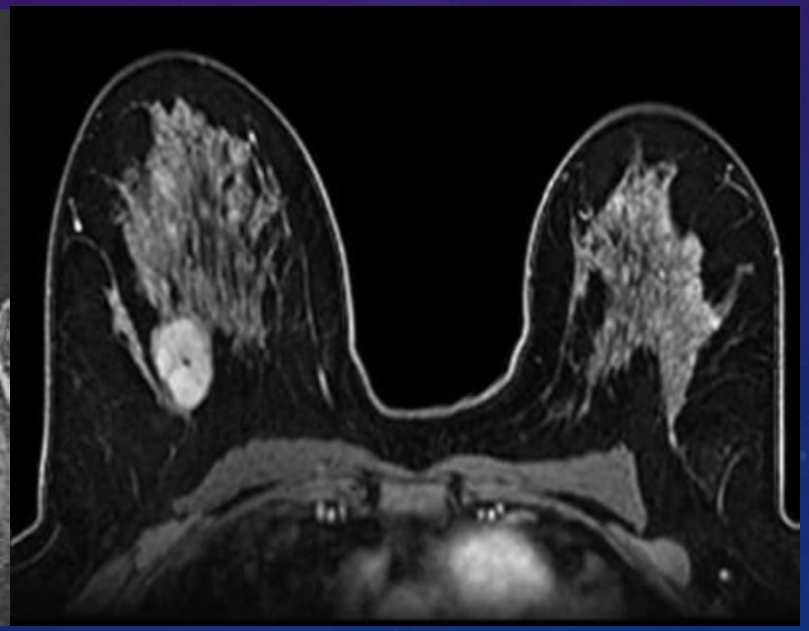


Figure 10. Large breasts. **(a)** Axial dynamic T1-weighted MR image shows inhomogeneous fat suppression medially (arrows) in both breasts. **(b)** Sagittal postcontrast delayed T1-weighted MR image shows inhomogeneous fat suppression superiorly (white arrow) and inferiorly (yellow arrow). **(c)** Axial postcontrast dynamic T1-weighted MR image shows bilateral breast compression anteriorly (arrows) against the coil or "anterior puddling." This may cause inhomogeneous inflow of contrast material and may obscure a retroareolar malignancy. Positioning may be improved by placing a pad on the coil underneath the patient's sternum so that the breasts hang freely, resulting in homogeneous fat suppression medially and laterally and resolution of the anterior puddling. **(d)** Axial postcontrast dynamic T1-weighted MR image shows homogeneous fat suppression bilaterally after placement of pad underneath the patient's sternum.

IMPROPERLY PLACED FOV BOX

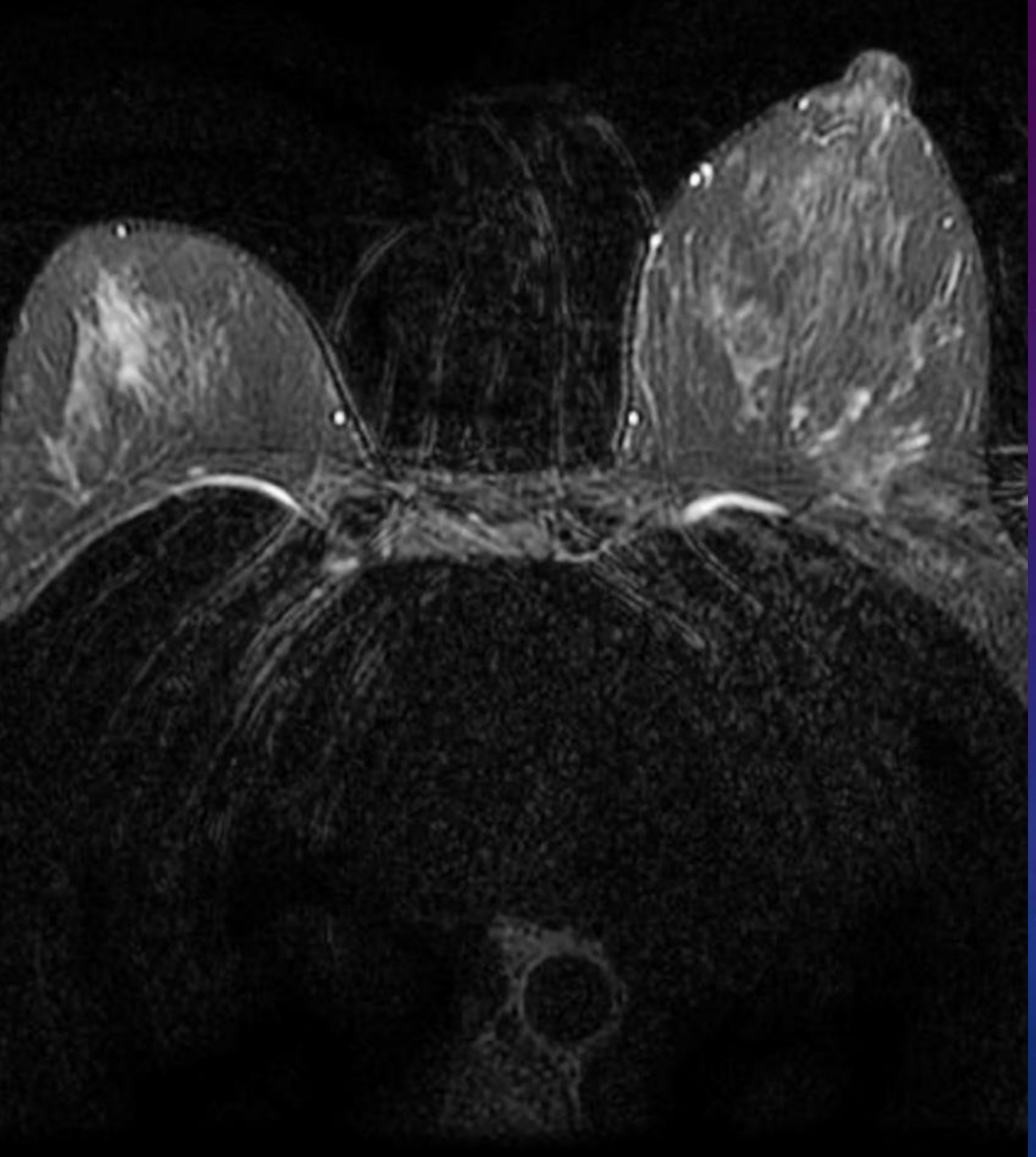


EXTREMELY IMPORTANT

The posterior portion of your FOV box should be at half the heart

-Improves homogeneity of fat suppression

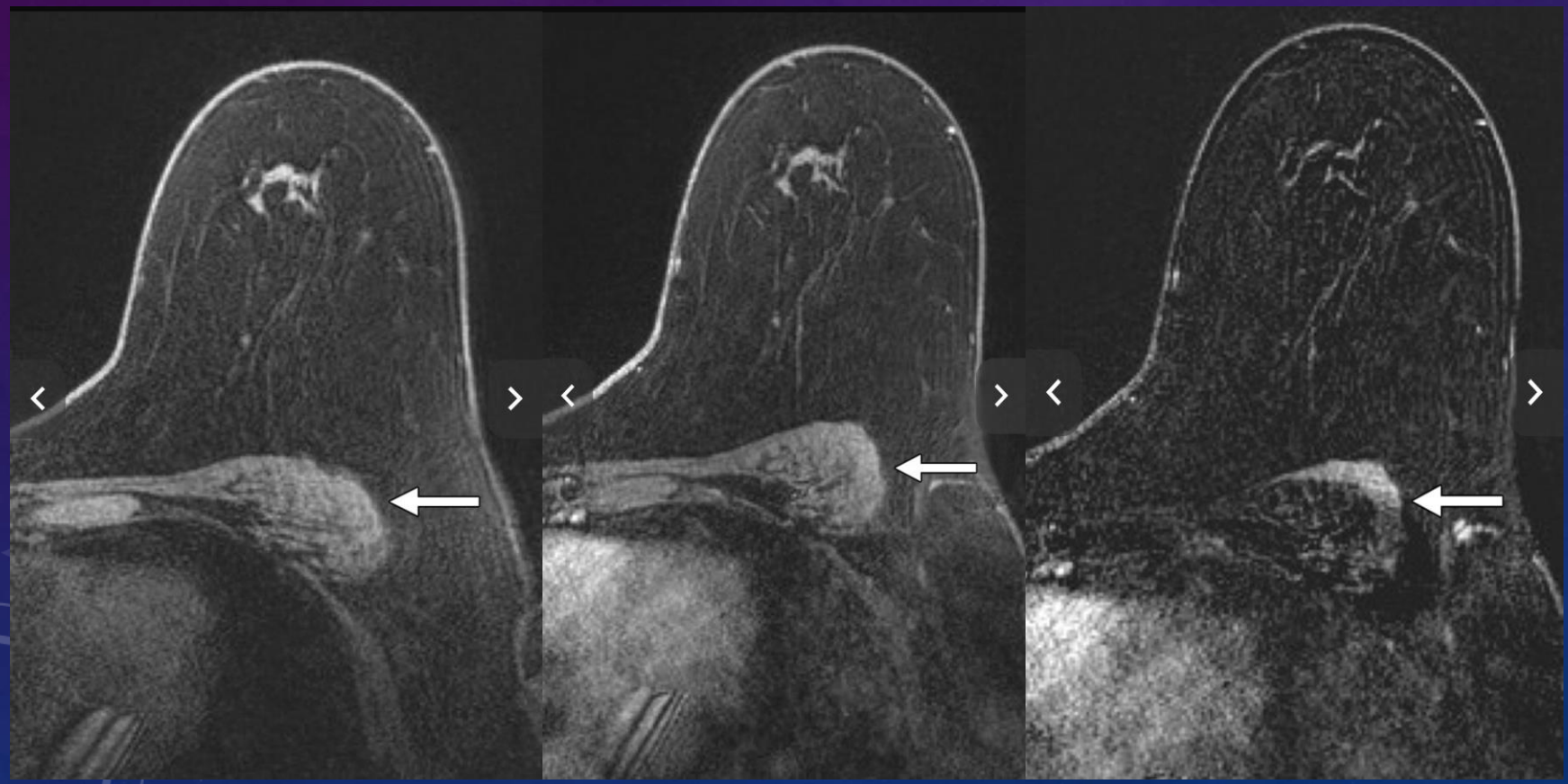
- Improves SNR in the breast
- Decreases cardiac motion artifact



MOTION ARTIFACT

- Ghosting is always in the phase encoding direction
- Can arise from patient motion, cardiac, respiratory, or great vessel motion
- Fix-properly placed FOV box, shorter scan times

MISREGISTRATION ARTIFACT



Motion between the unenhanced and contrast enhanced images resulting in an area that mimics enhancement on subtraction Images.

*On post contrast, leading edge of pectoralis is now in an area of fat c/w the precontrast. On subtraction images:

Tissue – fat=bright on subs

Fix- make sure patient does not move in between the pre and post contrast images

PROJECTED INCREASE IN BREAST MRI VOLUMES

On March 10, 2023, the FDA issued the final rule to amend the MQSA regulations. Facilities subject to the MQSA must comply with all applicable requirements, including the breast density notification, no later than September 10, 2024.

-House Bill 1058-State level legislation supports the changes issued by the FDA
-Informs patients whether they have dense breasts or not dense breasts
-Informs patients that dense breasts makes it harder to see a cancer and is a risk factor for cancer. Patients may benefit from supplemental screening(i.e. MRI)

Find It Early Act-Federal insurance bill that was introduced last year that would ensure no cost sharing for additional imaging(i.e. MRI) for high-risk individuals.

“Be not afraid of growing slowly; be afraid only of standing still”

Chinese Proverb

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