Hyperintense lesions on breast MRI inversion recovery sequences: not only cysts!

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Learning objectives

There are several breast MRI protocols being used that vary from site to site, but many of them include an **inversion recovery** sequence being STIR (Short Time Inversion Recovery) and SPAIR (Spectral Adiabatic Inversion Recovery) the most commonly used. The aims of this presentation are to:

1. Review the purpose of including this sequence as well as the term "hyperintense".
2. Describe some of the typical findings in these sequences such as cysts and edema and some other benign and malignant lesions that can be seen.
3. Point out its limitations and the importance of reviewing the whole breast MRI study correlating all the sequences as well as all previous imaging modalities available prior to getting to a possible diagnosis as metastatic lymph nodes and even carcinomas can look hyperintense in these sequences.
Background

Breast MRI has been increasingly world-wide used for both screening high-risk patients as well as diagnostic purposes such as in patients with occult breast cancer.

There are different protocols used regarding the scanning plane as well as the sequences included. However, they should all include:

1. Pre- and post-gadolinium T1-weighted images, preferably with fat suppression and simultaneously of both breasts.
2. A bright-fluid sequence (T2W or Inversion recovery imaging). [1]

If an inversion recovery sequence is included, fat is suppressed ("dark") and water ("bright"), even subtle increases in water content, are easily depicted. Inversion recovery sequences include at least 2 types: STIR and SPAIR.

On STIR, the objective is to separate the proton spins from fat away from the glandular spins due to the differences between the T1 relaxation times of the different tissues.

SPAIR (Spectral Adiabatic Inversion Recovery) uses a spectral selective adiabatic (=occurring without loss or gain of heat) inversion pulse to invert the fat spins and any remaining transverse magnetization is destroyed. The fat spins will decay and after a certain time the longitudinal magnetization will be zero. At this point, an excitation pulse is applied. As the fat spins have zero longitudinal magnetization, they will not contribute to the MR signal. [2]

The term "Hyperintense" implies that the signal intensity is higher ("brighter") than that of the surrounding fibroglandular tissue.
Findings and procedure details

The hyperintense findings in inversion recovery sequences prior to contrast administration include:

# Blood vessels: These can be seen longitudinally or transversally. As expected, they enhance with gadolinium. By scrolling back and forth throughout the study 9.5, these can be confirmed and distinguished from foci (Fig. 1).

# Simple cysts: Well-circumscribed, oval or round hyperintense masses, ranging from a few mm to cm, usually multiple and bilateral. In contrast sequences, they do not enhance (Fig. 2).

# Complicated cysts and oil cysts: If suspected cysts present rim enhancement ("contrast uptake in the periphery"), careful distinction between an inflamed cyst, oil cyst and a carcinoma should be made as this type of enhancement has a high PPV. The inflamed cysts, generally present a thin rim enhancement as opposed to the other ones. Also, looking at T2 W, non fat saturated sequences, second-look US should help reach a correct diagnosis [4]. Oil cysts, generally related to previous traumas and surgeries, are part of the fat necrosis process and thus the presence of fat and previous mammograms are very helpful in these patients (Fig. 3).

# Edema, skin thickening, seromas and hematomas: In patients with previous breast conservation surgery, who usually also receive radiation therapy, you can see these findings. As they all contain mainly fluid, these are hyperintense in IR sequences. Both the seromas as well as the hematomas can show rim enhancement, which is usually thin and regular. Postsurgical changes may enhance with contrast up to 18 months, during which period it may be hard to differentiate scar tissue from recurrence [5] (Fig. 4).

# Periimplant fluid: It is seen as hyperintense in contrast to the characteristic low signal of silicone implants in this sequence. It is NOT a sign of rupture as it can either represent reactive fluid in the surrounding tissue or saline in the outer component of a double-lumen implant [5] (Fig. 4).

# Fibroadenomas: can also appear hyperintense. This will depend on the proportion of its different components: glandular versus fibrous tissues, and if there are any calcifications developing. The more cellular, the more hyperintense. On enhanced sequences, they can enhance homogeneously or with thin dark septations (Fig. 5).

# Lymph nodes: axillary and internal mammary nodes can be hyperintense on inversion recovery sequences specially if they are either reactive or metastatic. You can not differentiate them based on the intensity or size on this sequence or time-intensity curve as they will likely show a type III curve. Thus, it is important to look at its morphology,
cortical-hilar relationship and patient’s clinical history. Ultrasound is very sensitive and if required, it can be used for guided- biopsy procedures (Fig. 6).

# Carcinomas: Both Invasive Ductal and in situ carcinomas can show an increase in signal, especially if there is a necrotic centre. These are generally masses that by changing the window level settings there might be some heterogeneity in it and above all they enhance with a thick and irregular rim (2). Also, carcinomas in situ can be hyperintense but not as bright as fluid in this sequence (Fig. 7).

# Artifacts: Metallic foreign bodies such as surgical clips and chemotherapy reservoirs can present a hyperintense area in STIR due to artifact. It is important to thoroughly assess all sequences and look for the void signal phenomenon in other sequences (Fig.8-9).

# Normal dense FGT: is seen with a high signal intensity, specially if it is dense and probably also depending on the time of the menstrual cycle that the scan is being done (Fig. 7).
Fig. 1: Axial SPAIR showing hyperintense blood vessels cut longitudinally and transversally mainly in the right breast.

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Fig. 2: Axial SPAIR sequence (a) demonstrates two round, well-defined and hyperintense masses in the deep central right breast. In the first post gadolinium sequence with subtraction (b), these do not enhance in this first sequence or in the latest.

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Fig. 3: Axial SPAIR (a) shows a hyperintense mass that after contrast (b) presents rim enhancement. This was confirmed to be a complicated cyst.

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Fig. 4: Patient who underwent left breast conservation surgery and radiation therapy 18 months ago. She had previously had bilateral augmentation mammoplasty. (a) Axial SPAIR with skin thickening and parenchymal edema which are hyperintense as well as periimplnat fluid and water droplets within the left implant. (b) Axial T2W, also shows water droplets and the "key- hole" sign (not seen in SPAIR) consistent with intracapsular rupture.

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Fig. 5: (a) Axial SPAIR on a 27 year-old female shows an oval, well-defined hyperintense mass in LUOQ lateral to the silicone implant. (b) In silicone-only sequence, this mass is slightly hypointense compared to the silicone implant. (c) T2W shows the mass is slightly hyperintense compared to fibroglandular tissue without being as bright as fat. These findings were concordant with the US representing a probable fibroadenoma.

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**Fig. 6:** 48 year-old female with previous bilateral augmentation mammoplasty. (a) STIR shows a prominent left axillary node. (b) T1W demonstrates a thick cortex with a central hilum preserved. FNA under US guidance confirmed a reactive node (patient had postsurgical infection and edema that ended up with explantation).

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Fig. 7: 52 year-old female that undergoes MRI. (a) T2W fibroglandular tissue in the central left breast, more linear. After contrast (b) there is a NME with a ductal distribution. STIR (c) demonstrates a hyperintense area only in that region even though after contrast more areas of FGT are seen in both breasts. A core biopsy was done under US and DCIS cribriform type with comedonecrosis (no invasive component) was diagnosed.

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Fig. 8: 45 year-old female with previous conservation therapy for right IDC. STIR in the right axillary region shows surgical clips which are hyperintense. Note that this can mimic a lymph node so correlation with other sequences is important.

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Fig. 9: Same patient as figure 8. (a) STIR shows a hyperintense "halo" around the chemotherapy reservoir (hypointense). (b) T2W also shows the void signal of the foreign body while the hyperintense surrounding area is harder to see as it is isointense to fat tissue.

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Conclusion

Breast MRI protocols may include inversion recovery sequences. If so, hyperintense findings on these sequences are not always benign or fluid-filled lesions. Therefore, careful analysis of the other sequences as well as clinical history and other breast imaging modalities should be reviewed as carcinomas and metastatic lymph nodes can also appear hyperintense.
References


