

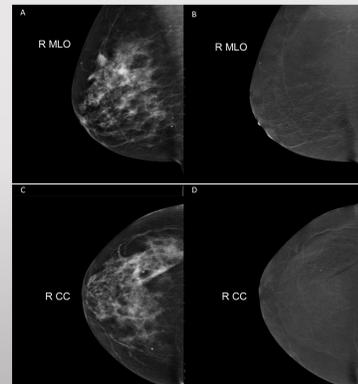
Introduction

Contrast-enhanced mammography (CEM) was approved by the U.S. Food and Drug Administration as an imaging modality for adjunct use in the diagnostic setting in 2011. CEM utilizes a dual-energy technique following intravenous administration of an iodinated contrast agent in order to identify abnormalities based upon the permeability/concentration of vessels found in certain tissues and tumors. Current indications for CEM include evaluation of screening recalls, evaluation of response to neoadjuvant chemotherapy, and assessment of disease recurrence. Additionally, CEM has demonstrated utility in women with dense breasts by increasing the detection sensitivity of malignancy and reducing false-negatives compared to traditional 2D mammography. CEM has potential implementation as both a primary and supplemental screening examination in women with dense breast tissue, and those at an intermediate lifetime risk of malignancy.

Contrast- Enhanced Mammography: Utility and Pictorial Review

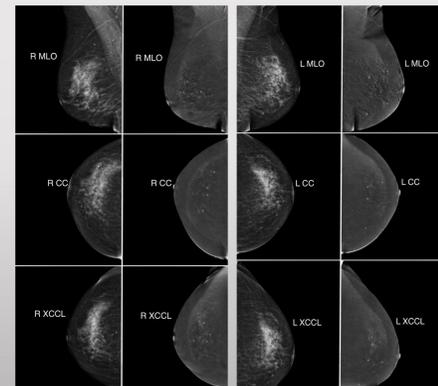
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Normal Exam



Normal Exam. Right breast standard (A,C) and contrast enhanced (B,D) mammography of a 71y.o. female referred for further evaluation following abnormal mammogram with questionable lateral breast focal asymmetry. Contrast enhanced images (B, D) demonstrate no suspiciously enhancing breast masses or asymmetries.

Fibrocystic Nodules



Bilateral Breast Masses. Paired standard and contrast enhanced mammographic images demonstrate multiple bilateral, well-circumscribed, enhancing, sub-centimeter masses (asterisks) typical of fibrocystic breast disease.

Fibroadenoma

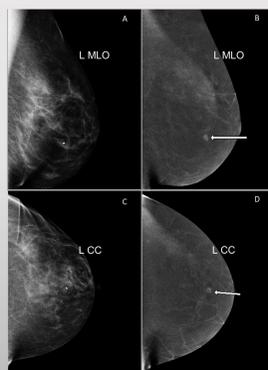


Figure 1. Left Breast Mass. Left breast standard (A,C) and contrast enhanced (B,D) mammography of a 48 y.o. female with palpable concern. Contrast enhanced images (B,D) demonstrate an oval, circumscribed, equal density enhancing mass at the 4-6 o'clock position (arrows).

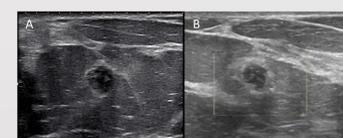


Figure 2. Left Breast Mass Ultrasound Correlate. Radial (A) and anti-radial (B) sonographic images at 6:00, 3cm from nipple demonstrate a round, circumscribed, parallel, hypoechoic 0.6 cm mass without posterior shadowing. Subsequent biopsy was consistent with fibroadenoma.

Invasive Ductal Carcinoma

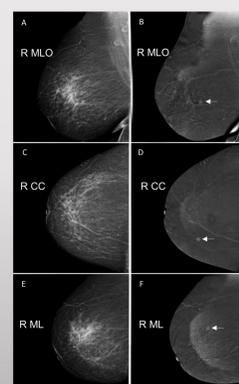


Figure 1. Right Breast Mass. Right breast standard (A,C,E) and contrast enhanced (B,D,F) mammography of a 38 y.o. female with mass identified on recent screening mammogram. Contrast enhanced images (B, D, F) demonstrate an enhancing, round, circumscribed, high density mass (arrows) at 3:00, 7 cm from the nipple.

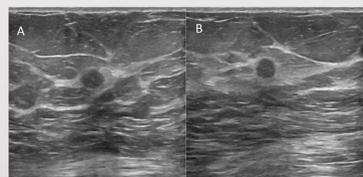


Figure 2. Right Breast Mass Ultrasound Correlate. Radial (A) and anti-radial (B) sonographic images at 2:00, 7cm from nipple demonstrate a round, circumscribed, parallel, hypoechoic 0.6 cm mass with mild posterior shadowing and surrounding architectural distortion. Subsequent biopsy results were consistent with invasive ductal carcinoma.

Invasive Lobular Carcinoma

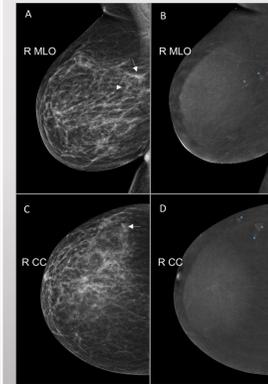


Figure 1. Right Breast Asymmetries. Right breast MLO and CC standard mammographic images (A,C) of a 71y.o. female referred for further evaluation following abnormal mammogram with asymmetries in the posterior third of the breast (arrows). Contrast enhanced images (B,D) demonstrate multiple irregular/spiculated enhancing masses with adjacent architectural distortion (asterisks).

Intraductal Papiloma

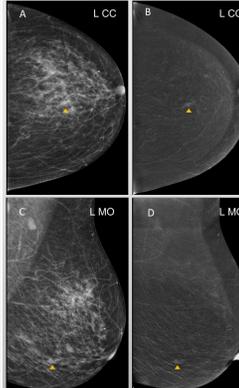


Figure 1. Left Breast Mass. Left breast standard mammography (A,C) of a 75 y.o. female with an abnormal and inconclusive finding on screening mammogram. Contrast enhanced images (B,D) demonstrate an enhancing, circumscribed lobular, mass with associated microcalcifications at 7:00, 7 cm from the nipple (arrow heads).

Low Grade Ductal Carcinoma With Radial Scar

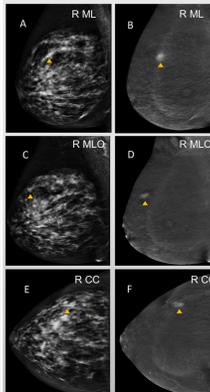


Figure 1. Right Breast Mass. Right breast standard (A,C,E) and contrast enhanced (B,D,F) mammography of a 76 y.o. female with findings of architectural distortion on screening mammogram. Contrast enhanced images (B,D,F) demonstrate an enhancing, spiculated, irregular mass exhibiting architectural distortion at 11:00, 8 cm from the nipple (arrow heads).



Figure 2. Right Breast Mass US Correlate. Ultrasound image of the right breast at 11:00, 8 cm from the nipple shows a hypoechoic shadowing mass 0.6 cm from the skin surface. Biopsy results were consistent with low grade ductal carcinoma and radial scar.

Complex Sclerosis with ADH

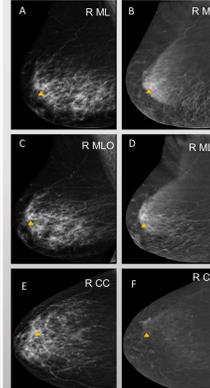


Figure 1. Right Breast Mass. Right breast standard (A,C,E) and contrast enhanced (B,D,F) mammography of a 78 y.o. female with abnormal findings on follow up screening mammogram. Contrast enhanced images (B,D,F) demonstrate an enhancing, indistinct, irregular mass with associated microcalcifications at 10:00, 6 cm from the nipple (arrow heads).

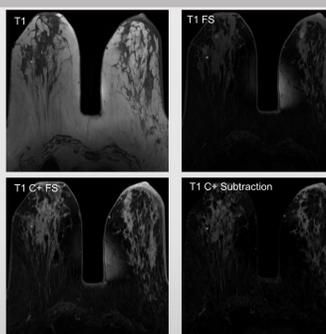


Figure 2. Right Breast Mass MRI Correlate . Breast CE-MRI demonstrates an irregular, heterogenous, T1 intermediate mass exhibiting avid enhancing on post-contrast images (asterisks). Biopsy results were consistent with complex sclerosis / ADH.

Sensitivity and Specificity

The sensitivity of CEM approaches that of CE-MRI at 89% and has also been found to have a lower amount false-positives when compared to CE-MRI. CEM has also been found to have a higher sensitivity than other modalities such as traditional MG or ultrasound. The specificity of CEM is higher than CE-MRI and is comparable to the specificities of MG and US.

Modality	CEM	CE-MRI	MG	US
Sensitivity	89%	90%	53%	52%
Specificity	84%	72%	91%	86%

Cost Considerations

Initial expenditures associated with CEM are significantly less than those required for CE-MRI. Furthermore, existing mammography units can often be retrofitted to perform CEM studies.

CEM is also a more affordable option for patients when compared to CE-MRI.

- CE-MRI generally requires a patient to undergo a conventional screening MG prior to receiving CE-MRI. Although variable the average total cost to the patient for both exams is approximately **\$950**.
- The low-energy imaging of CEM is similar to conventional MG in that no pre-screening is required. The average patient cost for CEM is approximately **\$195**.

Radiation Considerations

- CEM administers approximately 50% more radiation in comparison to standard 2D mammography but less than commonly implemented combined 2D mammography with 3D tomosynthesis.
- CEM requires placement of an IV line for contrast medium administration.
- Iodinated contrast carries a small risk of contrast induced nephropathy, thus renal function should be assessed prior to imaging.
- Iodinated contrast also carried a small risk of allergic reaction and anaphylaxis, for which patients with less severe cases can be pre-medicated.

CEM Modalities

The acquisition of CEM studies involves the injection of an iodine-based contrast agent. The typical dose of the contrast agent is 1.5ml/kg and the injection is automated. The contrast can remain present in breast tissue for up to 10 minutes which allows time for additional views such as spot compression or rolled views.

Temporal Contrast Enhanced Mammography (TCEM)

- Allows for the acquisition of tissue enhancement "time-curves" similar to those created using breast MRI.

Contrast Enhanced Spectral Mammography (CESM)

- Produces low-energy 2D images similar to those created using standard mammography as well as post-contrast mammographic images used to assess tumor neovascularity in a similar manner to contrast enhanced magnetic resonance imaging (MRI).

Contact Information

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