Contrast-enhanced spectral mammography (CESM) in a large scale breast cancer screening program. Preliminary clinical experience.

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Authors: A. Loshkajian¹, H. Sahmi², F. D'Antouard¹, C. Balleyguier³, C. Dromain³; ¹Creil/FR, ²Velizy/FR, ³Villejuif/FR

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Learning objectives

• To assess clinical performance of Contrast Enhanced Spectral Mammography (CESM) in a large scale breast cancer detection program.

• To illustrate the use of CESM for a better lesion classification, an improved clinical management, a better detection of missed lesions, a better clarification of equivocal mammographic and ultrasound images and a better selection of patients eligible for breast biopsy.

Background

X-ray mammography (MG) has reached a high standard in the detection of breast tumors. Major limitations of MG are the low contrast of non-calcified lesions and/or high density breast tissue. MG has a relatively high sensitivity in visualizing lesions but still fails to display every tumor and it lacks specificity. At MG, 10%-20% of breast cancers, including at least 9% of those already palpable, are not detected.

That's the reason why MG is supplemented by ultrasound (US) and, in inconclusive cases, by dynamic magnetic resonance imaging (MRI).

Full-field digital mammography systems offer new capabilities not provided by conventional film-screen radiography.

Clinical feasibility and initial experiences with Contrast enhanced mammography have been reported with two different techniques:

• Dynamic contrast-enhanced digital mammography (DCEM) using temporal subtraction
• Contrast enhanced spectral mammography (CESM) using dual energy.

Dynamic Contrast enhanced Digital Mammography (DCEM):

• DCEM with temporal subtraction involves a mask and a series of exposures, taken respectively before and after injection of contrast agent.
• In this technique, patient motion is the leading cause of artifacts observed on subtracted images that negatively impact the sensitivity for cancer detection.

Contrast enhanced spectral mammography (CESM):
Contrast-enhanced Spectral mammography (CESM) is a new breast imaging technique using full-field digital mammography in conjunction with the intravenous (IV) injection of an iodinated contrast medium.

CESM has proved its accuracy for the detection of breast cancer. The sensitivity of the MG is improved by IV contrast injection.

- With CESM, two images/projections are acquired almost simultaneously after contrast medium administration at different X-ray energies so that the X-ray absorption of the contrast medium is high in one case and low in the other.
- Because these 2 images are acquired post contrast, the compression does not influence wash-in/wash-out effects of the contrast medium into/out of the tumor. There are almost no motion artifacts.

The examination technique of CESM:

- A catheter is inserted into an antebrachial vein. A one-shot IV injection of 1.5 ml/Kg of non-ionic contrast agent is then performed, using a power injector at a rate of 3 ml/s.
- 2 minutes after the initiation of the contrast agent administration, the supposed pathologic breast is compressed in an MLO view and a pair of low and high-energy images is acquired. The same breast is then compressed in the CC position and a new pair of low and high-energy exposures is performed 3 min15 after the initiation of contrast agent administration.
- The supposed normal breast is then screened with the same technique 4min30 later for the MLO view and 5min45 later for the CC view. The 2 images for each projection are acquired almost simultaneously post contrast medium administration and are subsequently correlated for tumor visualization.
- The compression does not influence wash-in/wash-out effects of the contrast medium into/out of the tumor. There are almost no motion artifacts.
- A combination of low-energy and high-energy images through a specific image processing are performed in order to generate two recombined images with contrast agent uptake information (one in the MLO and another in the CC view).

In recent studies, CESM seems to have almost the same sensitivity than MRI for breast cancer detection (Dromain et al, IGR, Villejuif, France § Jochelson et al, MSKCC, NYC, USA).

Almost all studies with CESM published to date enrolled patients from Cancer Centers.

The questions we tried to answer in the present work are those encountered in any general breast imaging center:
- Is CESM useful in our daily practice for breast cancer detection and screening?
- Does CESM influence the clinical management of our patients:
- In a general breast cancer screening program?
- In the follow-up of previously treated patients for a breast cancer?

Our Study at CREIL Imaging Center is a prospective study which is still in progress.

**Imaging findings OR Procedure details**

The main indications for CESM could be "problem solving" in the case of equivocal MG and/or US assessments. It could be particularly of interest in dense breasts where the sensitivity of MG is lower. CESM could also be of special interest for patients with contraindications for MRI (metal implants, claustrophobia…)

In our study, inclusion criteria were:
- recalls from screening with unresolved findings after MG and/or US.
- high breast density on X-ray MG, heterogeneous or "difficult" US exams.
- MG/US examinations classified Bi-RADS 0, 3, 4 or 5.

Exclusion criteria were:
- refusal from the patient.
- pregnancy or possible pregnancy.
- previous history of allergy to an iodinated contrast agent.
- kidney malfunction.

A BiRads classification was scored before and after CESM.

**Our medical guidelines:**
• All patients enrolled in the study had a CESM combined with a US examination (first or second-look US).
• When a suspicious lesion was discovered or confirmed by CESM, an MRI and a biopsy were also scheduled in most of the cases.
• When an examination was reclassified to BiRads 2 or 1 after CESM, no further exploration was performed.
• BiRads 3 patients were under surveillance during the next 12 months. 3 of these patients were biopsied.
• A workstation (IDI) was used for image analysis. All images were reviewed by two experienced breast radiologist (Ara LOSHKAJIAN & François D'Anthouard).

Images for this section:

**Fig. 1:** Mammography of a 51 years old patient with a former left breast cancer treated in 1992. Suspicious palpable mass in the UIQ of the left breast. Family history of breast cancer (sister and mother).
**Fig. 2:** CESM examination demonstrating three focal enhancements in the left breast.
**Fig. 3:** Second look US exploration after CESM depicting a suspicious missed nodule of the left breast. The two other enhancements are not demonstrated on the US.
Fig. 4: MRI after CESM; three lesions are demonstrated, correlated with the CESM findings. The pathologic examination after radical mastectomy confirmed a triple location of an invasive ductal carcinoma.
Fig. 5: Routine mammographic screening in a 59 years old patient with a family history of breast cancer. Normal clinical examination.
Fig. 6: CESM examination demonstrating an occult enhanced lesion of the right breast missed on the routine screening MG/US.
**Fig. 7:** Second look US based on the CESM findings (left image) demonstrating an occult, missed lesion. An US-guided core biopsy (right image) confirms a small ductal cancer of the right breast.
**Fig. 8:** Routine mammographic screening in a 56 years old woman. Clinical palpation reveals multiple bilateral masses in both breasts. BiRADS 0.
**Fig. 9:** CESM of the right breast demonstrating a small enhanced lesion of the upper and upper quadrant of the right breast. BiRADS 4.
Fig. 10: A second look US, based on the CESM finding, reveals a small lesion of the right breast, missed on the former MG/US exploration.
Fig. 11: The MRI, performed after the CESM confirms a small malignant lesion of the right breast.
Fig. 12: Routine mammography in a 66 years old woman. Previous right breast surgery for a benign lesion. BiRADS 0.
**Fig. 13:** The CESM is considered as negative, without any suspicious enhancement of the breasts. The BiRADS classification is underscored to 2. The CESM could be used as a problem solving tool for the exploration of heterogeneous breasts.
Fig. 14: The MRI is correlated with the CESM. No suspicious enhancement is demonstrated.
Fig. 15: Routine follow up mammography in a 76 years old patient previously treated for a left breast cancer 19 years ago.
Fig. 16: A complementary CESM is performed, demonstrating a retroareolar lesion of the left breast. BiRADS 4.
Fig. 17: A second look US confirms a mass, suspected to be a cancer recurrence. The US guided core biopsy confirms the diagnosis.
**Fig. 18:** Routine mammographic screening in a 61 years old woman.
Fig. 19: A US examination is performed, demonstrating multiple non specific masses in both breasts. BiRADS 0.
Fig. 20: CESM performed after the routine MG/US examination. The masses don't enhance and are supposed to be benign. The radiologic file is reclassified to BiRADS 3 and then to BiRADS 2 after a year of follow up.
Fig. 21: Routine mammography in a 67 years old patient with a normal clinical examination, demonstrating a distorsion of the upper quadrants of the left breast. BiRADS 4.
**Fig. 22:** The US performed after the routine MG reveals 2 suspicious nodules of the left breast. BiRADS 4.
Fig. 23: CESM demonstrates two enhanced lesions, in correlation with the US. The biopsy of the left breast reveals both a malignant lesion and a fibroadenoma considered a false positive (FP) of the CESM. FP images are considered to be common findings with CESM, since the enhancement is not strictly correlated to the histologic type of the lesions. Other most common FP could be dystrophic nodules, cytosteatonecrosis, fibrocystic mastosis and lymph nodes.
Conclusion

This preliminary study in a large scale breast cancer screening program confirms the good diagnostic accuracy of CESM for breast cancer detection.

Compared with mammography alone, CESM increases the sensitivity without a loss in specificity.

Thanks to high specificity, CESM has the potential to improve the cancer detection rate, the staging and the selection of patients for biopsy.

CESM could also be of particular interest for the assessment of the extent of breast cancer, for dense mammograms, for the detection of contralateral and/or multifocal breast cancers, and for contra-indications of MR.

This technique should be considered a complementary tool to conventional digital MG.

Personal Information

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