Contrast enhanced spectral mammography: A literature review

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Learning Objectives

To gain an appreciation of current research regarding Contrast Enhanced Spectral Mammography (CESM) and the potential future uses of the diagnostic modality.
Background

Accurate local staging of the extent of breast cancer is important to ensure optimal treatment. Knowledge of the size of the primary lesion assists the surgeon in planning an adequate primary excision and avoiding the need for re-excision of more tissue to obtain clear pathological margins.

Malignancy in patients with breast cancer can be found at a site other than the primary lesion. This may be in the same quadrant of the breast (multicentric disease) in another quadrant (multifocal disease), or in the contralateral breast. In a study setting, 3.1% of patients with known breast cancer had additional malignant lesions found on MRI in the contralateral breast.[1]

Breast cancer detection can be challenging, particularly in dense breasts or breasts post-surgery, even with the addition of ultrasound examination. Contrast Enhanced MRI (CEMRI) is currently the most sensitive imaging modality for breast cancer diagnosis[2] however there are significant barriers to its widespread use including cost, accessibility and patient contraindications.

Using a similar principle to CEMRI, CESM can delineate malignant lesions by showing areas of abnormal contrast uptake associated with tumour neoangiogenesis and the presence of abnormal "leaky" vessels.[3] The diagnostic accuracy of CESM was found to be superior to both mammography and the combination of mammography with ultrasound.[4]

A recent study comparing imaging results with pathology found the addition of CESM to mammography with or without ultrasound increased the average per-lesion sensitivity of readers from 0.71 to 0.78 (p=0.006).[5]

CESM is currently being used in cancer centres in Europe and North America as a tool to further aid in cancer diagnosis and staging, with its role not yet completely defined.
Imaging Findings OR Procedure Details

The CESM Procedure:

Studies typically use an injection of non-ionic iodinated contrast (1.5mg/kg delivering 300mg I/mL) via an antecubital vein using either a power injector or manual injection at a rate of 3mL/s. Two minutes later standard mammographic views are performed with dual-energy exposures.

Commercially available CESM equipment can deliver dual energy X-rays in quick succession, with both a normal kVp and a higher energy (45-50kVp) exposure. CESM images have the same high spatial resolution as normal digital mammogram images.

All four views are obtained within 4 minutes of the injection. High energy and low energy exposures are subtracted from one another, taking advantage of the K-edge of iodine to produce images which demonstrate areas of contrast enhancement. The extra exposure is associated with minor increase in radiation dose to the breast (20% extra per image).[4]

The DICOM images produced can be displayed on standard PACS workstations and direct comparison between the routine views produced on non-contrast mammography and CESM is possible.

CESM Compared to other Novel Breast Imaging Techniques:

Advantages of CESM include:

- Allows imaging of both breasts
- Similarity of the examination to normal mammography allows for ease of radiographer training
- Examination is virtually the same as regular mammography for patients which is likely to result in higher patient acceptance
- Suitable for patients unable to undergo MRI (claustrophobia, metallic implants and other contraindications)
- Similarity of projections used with normal mammograms beneficial to both radiologists and clinicians

Disadvantages of CESM include:

- The need for IV contrast - not suitable for patients with renal impairment and there is also the risk of contrast reactions
Comparison with Sequential Contrast Enhanced Mammography:

Full field digital mammography (single energy) is currently being performed with several timed images (pre-contrast and then post-contrast at 60, 120, 180 and sometimes 240 seconds).[6] This technique, like CEMRI, provides enhancement curves which can help characterise a lesion. There are disadvantages - only one breast can be imaged in a single projection, to allow for the assessment of enhancement kinetics. A difficulty of the technique is balancing adequate compression (minimising patient movement to allow for subtraction as well as improving image quality and lowering radiation dose) without compromising vascularity.

Breast Tomosynthesis:

Tomosynthesis of the breast is being performed both with and without IV contrast. The X-Ray generator and panel detector move in an arc around the stationary compressed breast, collecting multiple images which undergo reconstruction and are presented similarly to a CT or MRI.[7] This can provide slices as thin as 0.5mm allowing for detection of small lesions. Disadvantages include the need for a markedly different system requiring further radiographer and radiologist training, and more time to both perform and read the examinations. As methods are still being developed by manufacturers, particularly with regards to contrast enhanced tomosynthesis, radiation doses are unclear, but thought likely to be similar to CESM.
Conclusion

Emerging literature suggests potential uses for CESM include: accurate local staging of disease (lesion size, multifocality and assessment of contralateral breast) and examination for disease recurrence. CESM may provide similar information to CEMRI with greater accessibility, less patient discomfort and at a lower cost.

Further research is needed to better define the role of CESM in breast cancer diagnosis and treatment planning, as well as to determine its efficacy compared with CEMRI.
References


