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ORIGINAL ARTICLE

Comparison Between Contrast-enhanced Mammography and Tomosynthesis in Assessment of Breast Lesions

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Abstract

Background: **Mammography is criticized for having poor specificity and sensitivity in breast parenchyma that is dense. Additionally, breast cancer risk is higher in women who have dense breast tissue. Tomosynthesis and contrast-enhanced mammography are relatively new imaging methods that have been linked to breast cancer identification and diagnosis.**

Objective: **To evaluate breast lesions using both breast contrast-enhanced mammography and tomosynthesis.**

Patients and methods: **In total, 50 patients participated in this prospective trial, and each had single-view tomosynthesis and contrast-enhanced mammography. The research was carried out between March 2021 and February 2022 at Mediant Al Tab Hospital and Behia Center's Radiological Department, and it was authorized by the ethics committee. Specific computer statistical software was used to gather and evaluate the radiological and histopathological findings.**

Results: **Contrast-enhanced mammography was shown to have a 95.5 % sensitivity, an 80 % specificity, a 97.7 % positive predictive value, and a 66.67 % negative predictive value. Tomosynthesis demonstrated an 88.9 % sensitivity, 60.0 % specificity, 95.2 % positive predictive value, and 37.5 % negative predictive value.**

Conclusion: **Breast contrast-enhanced mammography outperformed tomosynthesis in detection and classification of breast lesions according to BIRADS category, multiplicity (multifocal or multicentric) of lesion, and follow-up of response to therapy, but in size of lesion, no significant different results were detected.**

Keywords: Contrast-enhanced mammogram, Dense breast, Tomosynthesis

1. Introduction

One significant cancer-related cause of mortality in women is breast cancer. The results and survival rate of breast cancer are improved by early diagnosis.[1]

Despite the availability of a number of additional breast imaging modalities, including breast MRI and ultrasound, mammography remains a crucial tool in the identification and monitoring of breast cancer. The fact that the diagnostic accuracy of mammography is highly dependent on breast density is one of its most significant limitations.[2]

Iodinated contrast agents are a unique imaging method that uses a dual-energy methodology to identify breast cancer in (contrast-enhanced) mammography. It is predicated on the increased permeability inside tumor areas and the contrast enrichment brought on by newly generated, growing tumor vasculature. After the injection of iodine contrast medium, contrast-enhanced spectral mammography is carried out using high-energy (HE) and low-energy (LE) acquisitions to acquire the recombined images of bilateral breasts. While the HE image shows postcontrast improved mammograms by employing the K-edge impact of iodine to assess tumor neovascularity, the LE image reveals morphological information comparable to two-dimensional digital mammography. These advantages have made CESM an effective alternative

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scanning method for the early diagnosis of breast cancer.[3]

Digital breast tomosynthesis (DBT): quasi-3D imaging of the breast is provided, reducing the superimposition of breast tissue and enhancing cancer diagnosis. Previous research has shown that DBT reduced recall rates and increased cancer detection rates, improving the sensitivity, specificity, and accuracy of full-field digital mammography.[4]

This technique has been shown in numerous retrospective and prospective studies to be acceptable to women, improve radiation dose by 20 % on a median, enhance cancer detection by 15–30 %, and reduce recall rates by 15–20 % by decreasing overlapping shadows mimicking breast cancer. The conspicuity and analysis of microcalcification were not enhanced, despite the approach being effective for evaluating soft tissue masses, architectural distortion, and asymmetries.[5]

The contrast agent approach often offers further assistance in situations that mammography or tomosynthesis cannot fully clarify, such as in instances of exceptionally thick breast tissue, preoperative staging, or follow-up of scars. The technique provides an alternative to MRI, which, when used, takes longer and may be fairly expensive in many constellations.[6]

2. Patients and methods

The research included 50 patients (27–80 years), their mean age was 49.8 ± 10.58 years. Patients were referred to the Radio Diagnosis Department from the Oncology Units in Mediant Al Tab Hospital and Behia Center. They all conducted breast ultrasonography, contrast-enhanced spectral mammography, single mediolateral oblique (MLO) or CranioCaudal (CC) view tomosynthesis, and mammography. The investigation was given ethics committee approval, and all individuals provided written informed permission before the study could proceed. The final diagnosis was made via histological examination of biopsy samples. A single-consultant radiologist with more than 10 years of expertise in sophisticated breast imaging mammography methods performed the image interpretation.

2.1. Inclusion criteria

Patients with mammography dense breast on screening who have unclear mammographic results and symptomatic patients with dense breast categorized as C or D by the ACR BIRADS terminology.

2.2. Exclusion criteria

Pregnancy is a contraindication to mammography, among other things. Patients with renal impairment, allergic patients, or those known to have a history of anaphylactic response to contrast media, as well as those whose breast density is classed as ACR A or B, are examples of those who should not receive intravenous contrast.

2.3. Technique of three-dimensional tomosynthesis

Senographe Essential, a GE HealthCare (Chicago, United States) Full Field Digital Mammography equipment, was used to acquire a single view (MLO) or (CC) for the 3D digital tomosynthesis. A dedicated workstation was used to evaluate the images.

2.4. Mammography image interpretation and analysis

Each lesion's location and kind (mass, architectural distortion, and localized asymmetrical calcifications) were assessed. According to the 2013 BI-RADS Atlas, we gave each lesion a BI-RADS category. The interpreting radiologist was aware of the clinical information but was unaware of the end outcomes of the pathology.

2.5. Image interpretation and analysis of contrast-enhanced mammography

Since there is no longer a distinct vocabulary for CESM, lesions were described using the 2013 MRI BI-RADS lexicon morphological descriptors.

2.6. Image analysis and interpretation of tomosynthesis

Each lesion's location and kind (mass, architectural distortion, and localized asymmetrical ± calcifications) were assessed.

2.7. Statistical analysis

When applicable, data were statistically reported utilizing the range, mean, SD, frequencies (number of instances), and percentages. Sensitivity, specificity, positive predictive value, negative predictive value, overall accuracy, probability ratio of a positive test, and the probability ratio of a negative test were utilized to describe accuracy.

Table 1. Summarizes the statistical evaluation of tomosynthesis.

	Pathology		Total
	Positive	Negative	
Tomosynthesis finding			
Positive	40	2	42
	88.9 %	40.0 %	84.0 %
Negative	5	3	8
	11.1 %	60.0 %	16.0 %
Total	45	5	50
100.0 %	100.0 %	100.0 %	

Sensitivity = 88.9 %.
Specificity = 60 %.
Positive predictive value = 95.2 %.
Negative predictive value = 37.5 %.

Table 2. Summarizes the statistical evaluation of CEM.

	Pathology		Total
	Positive	Negative	
CEM finding			
Positive	43	1	44
	95.5 %	20 %	88 %
Negative	2	4	6
	4.5 %	80 %	12 %
Total	45	5	50
100.0 %	100.0 %	100.0 %	

Sensitivity = 95.5 %.
Specificity = 80 %.
Positive predictive value = 97.7 %.
Negative predictive value = 66.67 %.
CEM, contrast-enhanced mammography.

3. Results

Table 1 shows that tomosynthesis was performed for 50 patients. In total, 42 lesions appear as malignant on tomosynthesis, 40 of them were truly malignant (true positive), while the other two lesions were benign (false positive). Another eight lesions appear as benign on the mammogram, five of them were truly benign (true negative), while the other three lesions were malignant (false negative).

Table 2 shows that contrast-enhanced mammography (CEM) was performed for 50 patients. In total, 44 lesions appear as malignant, 43 of them were truly malignant (true positive), while the other one lesion was benign (false positive). Another six lesions appear as benign on CEM, four of them were truly benign (true negative), while the other two lesions were malignant (false negative).

Table 3. Involvement of left and right axilla.

	Left axilla		Right axilla	
	Frequency	Percent	Frequency	Percent
Negative	30	60	28	56
Positive	20	40	22	44
Total	50	100	50	100

Table 4. Distribution of pathological results among microcalcification.

	Frequency	Percent
Malignant	21	91.3
Benign	2	8.7
Total	23	100.0

Table 5. Number of lesions detected in CEM and tomosynthesis.

	Group	*N*	Mean	SD	*P* value
Number	Tomosynthesis	50	1.3600	0.96384	0.01
	CEM	50	1.9400	1.21907	

Table 3 shows that involvement of axillary lymph node 40 % at the left side, 44 % at the right side.

Table 4 shows that 23 cases were detected with microcalcification, −21 (91.3 %) of them have malignant lesion, while two (8.696 %) cases show benign lesion.

Table 5 shows that there is a significant difference between tomosynthesis and CEM in number of lesions.

Table 6 shows the size (volume) of different lesions in tomosynthesis and CEM, which show no significant difference in size (volume) of lesions that were detected (Table 7).

4. Case presentation

4.1. Case: 1

A female, 46 years old, presented with palpable left breast lump for 1 year.

4.1.1. Findings

Tomosynthesis: left breast: shows LIQ ill-defined mass lesion with calcification foci associated with multiple left axillary lymphadenopathies (LAP).

Right breast: normal, no mass lesion seen.

4.1.2. BIRAD 4

CEM: Left breast: shows LIQ heterogeneous nonmass enhancement measured 10 × 6 cm, located 1.6 cm from the nipple, also, there is a small faint enhancing foci seen at UOQ.

Table 6. Size of lesion in tomosynthesis and CEM.

	Group	Mean rank	Sum of ranks	P value
Size of lesion left breast	Tomosynthesis	32.76	1015.50	0.914
	CEM	32.26	1064.50	
Size of lesion right breast	Tomosynthesis	30.83	709.00	0.494
	CEM	27.76	944.00	

Table 7. Comparison between tomosynthesis and CEM.

	Tomosynthesis	CEM	Note
Location of lesions			
Right breast	31 %	38 %	
Left breast	53 %	52 %	
Bilateral	16 %	10 %	
Sensitivity	88.9 %	95.5 %	
Specificity	60 %	80 %	
PPV	95.2 %	97.7 %	
NPV	37.5 %	66.67 %	
Number of lesions detected			
Mean	1.3600	1.9400	There is significant difference P value = 0.01
SD	0.96384	1.21907	
Size of lesion			
Left breast			
Mean rank	32.76	32.26	There is no significant difference P value = 0.914
Sum of rank	1015.50	1064.50	
Right breast			
Mean rank	30.83	27.76	There is no significant difference P value = 0.494
Sum of rank	709.00	944.00	
BIRAD II	4.0 %	2.0 %	
BIRAD III	14.0 %	8.0 %	
BIRAD IV	52.0 %	20.0 %	
BIRAD V	24.0 %	66.0 %	
BIRAD VI	4.0 %	4.0 %	

NPV, negative predictive value; PPV, positive predictive value.

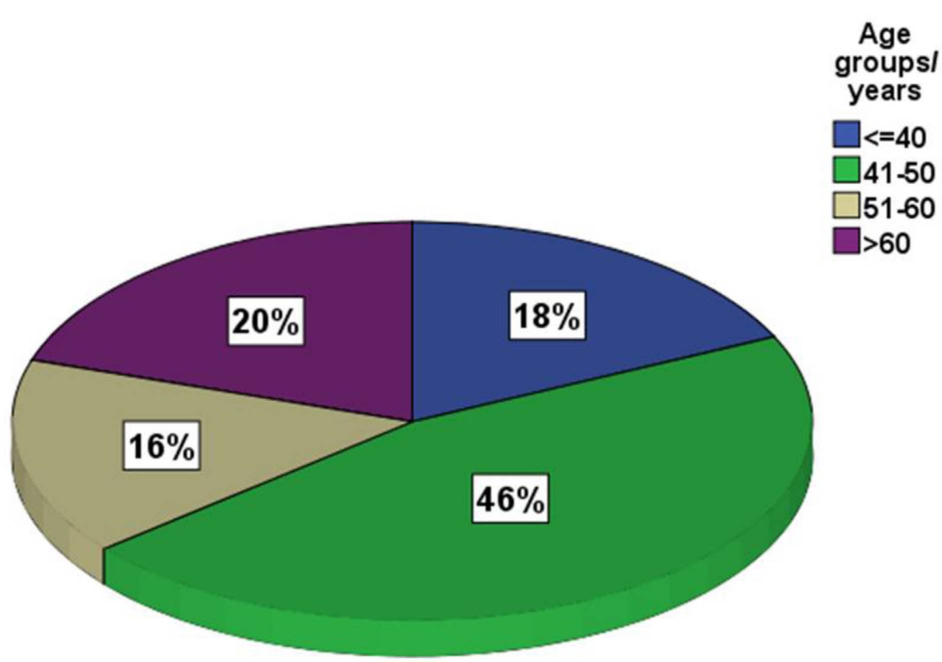

Fig. 1. Patients ranged in age from more than or equal to 40 years old in 18 % of cases to between 41 and 50 years old in 46 % of cases, between 51 and 60 years old in 16 % of cases, and less than 60 years old in 20 % of cases.

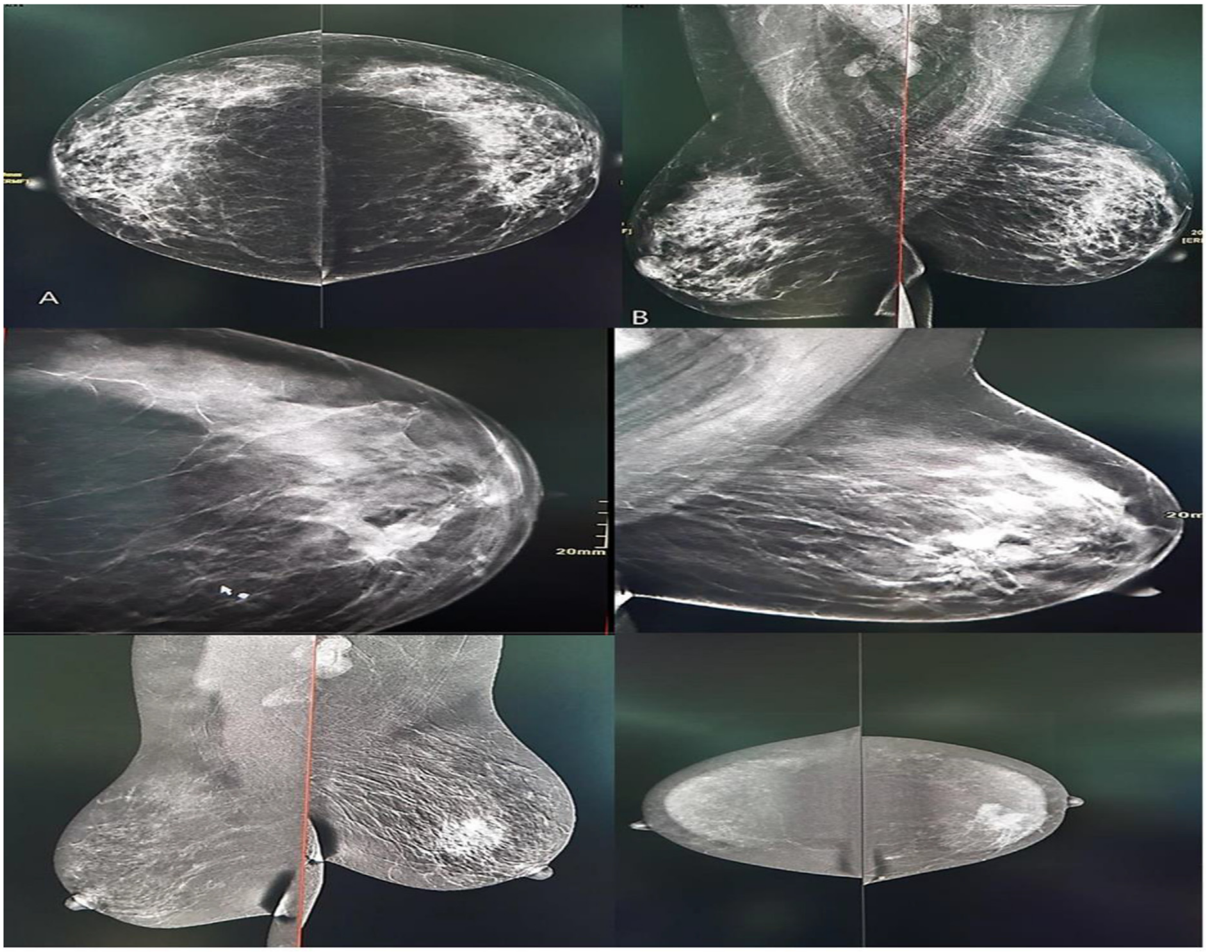

Fig. 2. (A–C) CC and MLO view of tomosynthesis, (D–F) CC and MLO view of CEM.

Right breast: normal, no mass lesion seen (see Fig. 1).

4.1.3. BIRADS 5

Diagnosis: GII-invasive ductal cancer (Fig. 2).

4.2. Case: 2

A female, 53 years old, presented for screening.

4.2.1. Finding

Tomosynthesis: left breast: scattered and grouped microcalcification foci with architectural distortion at LIQ measured 4.7 × 3.8 cm.

Right breast: normal, no mass lesion seen.

4.2.2. BIRADS 4

CEM: left breast: mild background enhancement, no significant lesion seen.

Right breast: mild background enhancement, no significant lesion seen.

4.2.3. BIRADS 3

Diagnosis: invasive lobular carcinoma (Fig. 3).

5. Discussion

The most prevalent cancer and the second leading cause of cancer mortality in women is breast cancer. Maximizing cancer diagnosis and reducing pointless tests and procedures are both possible with an effective and accurate assessment.[7]

Technological advances in combining tomosynthesis with CEM have produced an even higher diagnostic accuracy, while the main imaging technique for detecting and diagnosing breast cancer is mammography.[8]

In the present research, we evaluated the effectiveness of three-dimensional tomosynthesis and contrast mammography. The research included 50 patients (27–80 years) to evaluate the tomosynthesis and CEM imaging role in the final diagnosis using the histopathological results as the gold standard for reference.

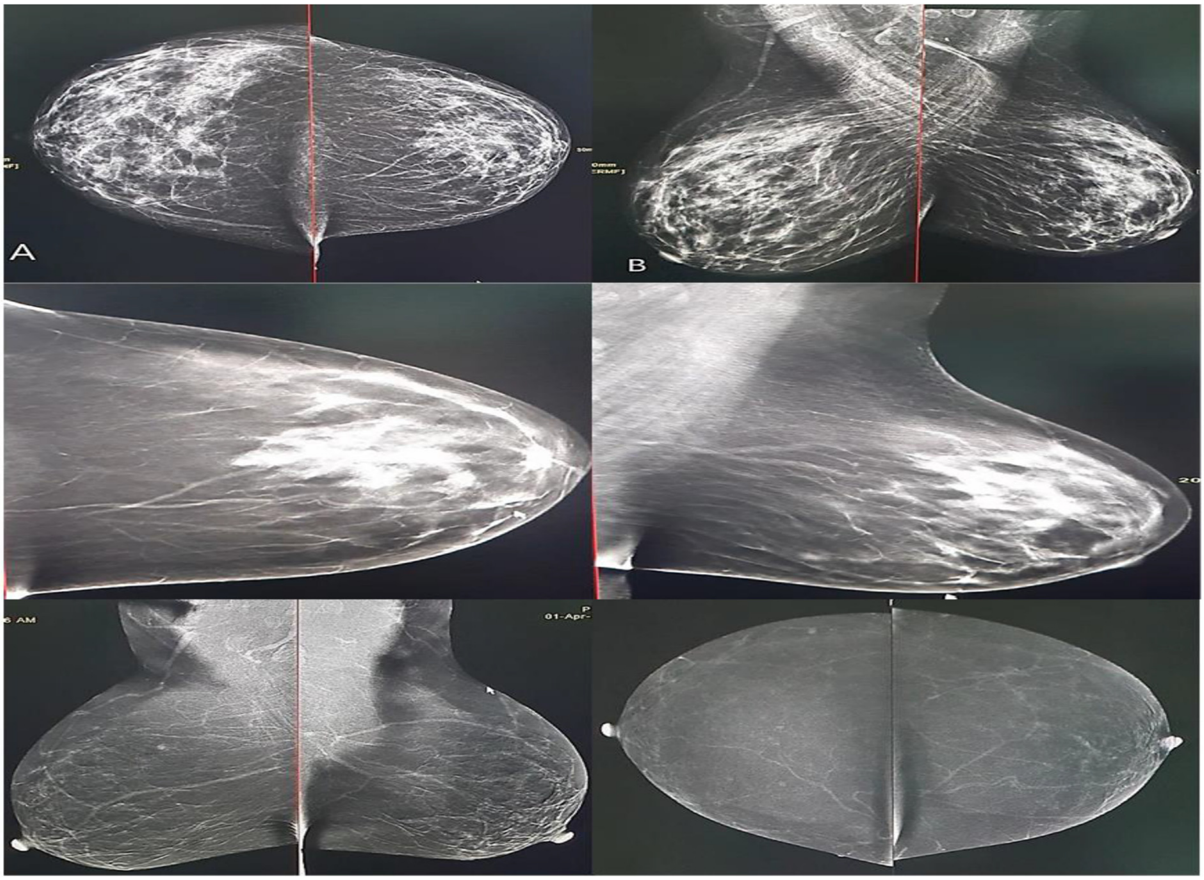

Fig. 3. (A–C) CC and MLO view of tomosynthesis, (D–F) CC and MLO view of CEM.

Regarding imaging results, mass lesions (64 %) and breast screening (26 % of presentations) were the most frequent. Breast discomfort (6 %), 4 % nipple bleeding.

In our study, we found 22 (52 %) patients involved the left breast in tomosynthesis study and 24 (53 %) patients involved the left breast in CEM, which coincides with Von Fellenberg R. Schweiz[9] who revealed that the left breast is more likely than the right to develop unilateral breast tumors.

Our study shows axillary lymph node involvement 40 % (20 positive, 30 negative) on the left side, while 44 % (22 positive, 28 negative) on the right side.

In the current study, the tomosynthesis examination of both benign and malignant lesions showed an overall sensitivity of 88.9 %. Our results were comparable with Fiorica[10] who revealed that in dense breasts, DBT demonstrated improved sensitivity and specificity in contrast to mammography.

Comparing the sensitivity and specificity of CEM imaging in this research, we found that the sensitivity for detection of malignancy was 95.5 %, the specificity for characterization was 80 %, positive predictive value was 97.7 %, and the negative predictive value was 66.6 %.

Dual-energy imaging is used in contrast-enhanced mammography to detect and classify lesions based on angiogenesis as well as morphologic characteristics and density. Additionally, microcalcifications, architectural distortion, and nonenhancing lesions could all be seen on CEM using LE pictures.[11]

CEM gives functional data in addition to morphology, increasing the sensitivity and specificity of mammography.[11]

Our study shows detection of calcification as 88.46% microcalcification, 11.54% macrocalcification was 8.7 % as benign calcification, and 91.3 % as malignant calcification.

A preliminary analysis of the calcification conspicuity at DBT revealed that, in more than half of instances, it may be inferior than that at FFDM.[12]

In as many as 92.2 % of patients, more recent investigations found that picture quality was on par with or superior to that of FFDM. These findings demonstrate that technological advancements may enable calcification visualization at DBT comparable to that at FFDM. This included higher conspicuity at DBT than at FFDM in almost half of the instances.[13,14]

Our study shows comparison between tomosynthesis and CEM in number of lesions that were detected in both tools. There is a significant difference between tomosynthesis and CEM in number of lesions as CEM is better in detection of breast lesion, this matches with a study done by Moustafa et al.[15] who revealed that although CESM had a high sensitivity of 100 % for detecting multiplicity, its specificity of 97.3 % was less than ideal since certain benign lesions, such as inflammatory lesions, some benign tumors like fibroadenoma, and intraductal papillomas might exhibit a considerable increase.

Measurement of tumor size is a critical factor in determining treatment option and monitoring treatment response, so in our study, the size (volume) of different lesions in tomosynthesis and CEM, shows no significant differences (volume) that were detected.

This result was against the study done by Bozzini et al.[16] The CESM gives extra information with consistent enhancement to the cancer diagnosis in dense breasts and evaluation of tumor size, according to research that was conducted on a large cohort of patients.

5.1. Conclusion

Although mammography and ultrasound remain the primary diagnostic imaging modalities for the breast evaluation worldwide, several studies and this initial experience also proved that CEM has higher diagnostic value that can enhance the process of early cancer diagnosis, postoperative follow-up, and treatment plans. However, CEM has a few limitations such as administration of iodinated contrast media with low risk of contrast reactions, theoretical risk from radiation exposure, and low rates of false-positive and false-negative results.

CEM is an emerging technique that can be used for multiple diagnostic breast imaging indications with a sensitivity and specificity approaching that of DCE-MRI, particularly in dense breast. The main advantages of CEM are providing rapid streaming to treatment and allowing diverse diagnostic breast MRI resources to be available for other purposes such as supplementary screening.

Consent statement

It was approved by the faculty Ethical Committee and the faculty Council.

Conflicts of interest

None declared.

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