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Original Research Article

Evaluating Suspicious Breast Lesions: A Head-to-Head Comparison of Contrast-Enhanced Mammography and Breast MRI

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Abstract: ***Background***: Magnetic resonance imaging (MRI) is the most sensitive technique for the detection of breast cancer in contemporary medical practice. Contrast-enhanced mammography (CEM), a novel technology, provides a contrast-enhanced imaging alternative to breast MRI. ***Objectives***: to assess the diagnostic efficacy of CEM in the characterization of suspicious breast lesions, with histopathological results serving as the gold standard. Compare CEM with dynamic contrast enhanced MRI (DCE-MRI). ***Patients and Methods***: 30 individuals with suspicious lesions identified using conventional mammography or ultrasonography underwent CEM and DCE-MRI examinations after receiving ethical approval. Proficient radiologists evaluated all discernible lesions using the Breast Imaging Reporting and Data System (BI-RADS) classifications (categories 1–6). Histopathological data were compared to the morphological descriptions of each lesion that were received from each modality. ***Results***: 30 lesions were identified by the combination of breast MRI and CEM in the 30 patients who were enrolled in CEM/MRI investigations. Histopathology verified that 15 of the 30 lesions were malignant and 15 were benign. Twelve of the fifteen malignant lesions were invasive cancers, while three were in situ cancers. Both breast MRI and CEM demonstrated a sensitivity of 93.33%. The specificity of breast MRI was 93.33%, while CEM had a specificity of 80.00%. The breast MRI achieved an accuracy of 93.33%, while the CEM achieved an accuracy of 86.67%. ***Conclusions***: Contrast-enhanced mammography (CEM) has the potential to replace dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) as a problem-solving instrument for the characterization of indeterminate breast lesions, particularly in situations where MRI is contraindicated or not promptly accessible. CEM provides a viable alternative for evaluating ambiguous lesions, as it utilizes similar principles of contrast enhancement and tumor vascularity. However, it has the additional benefit of being more broadly available, less expensive, and better tolerated by specific patient populations.

Keywords: Contrast Enhanced Mammography, magnetic resonance imaging (MRI), Breast, Lesions.

INTRODUCTION

The accurate diagnosis and characterization of breast lesions play a critical role in the effective management and improved prognosis of breast cancer [1, 2]. Among various imaging techniques, mammography has been established as the primary modality for the screening and early detection of breast cancer. Despite its widespread use, one limitation of mammography is its relatively low sensitivity and specificity, particularly in women with dense breast tissue [3]. While mammography remains the internationally preferred method for early breast cancer detection due to its accessibility and cost-effectiveness, it is important to note that alterations in breast tissue can often be identified on mammograms up to two years before clinical symptoms appear, underscoring its significance in the early stages of disease detection [4]. The accurate diagnosis and characterization of breast lesions play a critical role in the effective management and improved prognosis of breast cancer [1, 2]. Among various imaging techniques, mammography has been established as the primary

modality for the screening and early detection of breast cancer. Despite its widespread use, one limitation of mammography is its relatively low sensitivity and specificity, particularly in women with dense breast tissue [3]. While mammography remains the internationally preferred method for early breast cancer detection due to its accessibility and cost-effectiveness, it is important to note that alterations in breast tissue can often be identified on mammograms up to two years before clinical symptoms appear, underscoring its significance in the early stages of disease detection [4].

Lesion characterization using dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) relies on the differences in vascular supply between normal and neoplastic tissue. Neoplastic tissues exhibit increased contrast uptake due to the development of neovascularization, a hallmark of malignant growth [5]. However, DCE-MRI has lower specificity compared to mammography, primarily due to the potential for false-positive results associated with contrast enhancement in benign breast parenchyma. Additionally, the high cost, lengthy imaging times (30-40 minutes), and various contraindications—such as the presence of pacemakers, intracranial aneurysmal clips, cochlear implants, and claustrophobia—have prompted ongoing research to explore alternative contrast-based mammographic techniques [6].

The comparison between Contrast-Enhanced Mammography (CEM) and Breast MRI (CEMR) reveals significant insights into their diagnostic capabilities, accessibility, and patient comfort. While both modalities are effective in breast cancer detection, CEM offers a more accessible and cost-effective alternative to CEMR, with comparable diagnostic accuracy [7].

Contrast Enhanced Mammography (CEM) primarily uses Iohexol, while Breast MRI (CEMR) uses Gadopentetic acid (Gd-DTPA). Both methods are safe, with low rates of allergic reactions (0.13% for CEM and 0.004% for CEMR) reported in the literature [8].

The aim of the study is to compare the diagnostic performance of CEM with dynamic contrast enhanced MRI (DCE-MRI) in characterization of suspicious breast lesions taking the histopathological results as the gold standard.

METHOD

Study Design:

A prospective study that conducted at oncology teaching hospital /Medical City in Baghdad. During the period from May 2022 to February 2023.

Patients:

The female patients that participated in this study, whether for diagnostic or screening purposes, will be recruited in the study after oral consent.

Inclusion Criteria

Any female patient that has breast lesion categorized as BIRADS IV or V (by ultrasound or mammography).

Exclusion Criteria:

1. Patient with recent history of breast surgery.
2. Patient with breast implant.
3. Patient contraindicated to MRI.
4. Patient contraindicated to intravenous iodinated contrast (due to allergy, renal impairment or other medical causes like thyrotoxicosis)
5. Patient receiving radiotherapy.

The referred patient will be examined by contrast enhanced mammography and DCE-MRI. Ultrasound were done for all patients as part of complete work up. The end results will be correlated with biopsy results.

Data Collection

Relevant clinical history like (age, presenting complain, and family history of breast malignancy) were recorded, as well as the breast imaging findings in (mammography and contrast enhanced mammography), then the patients were referred to the MRI unit. The histopathological results for the lesions were obtained later.

Contrast-Enhanced Mammography Technique

CEM examination was performed using Senographe pristine, GE healthcare full-field digital mammography machine. A one-shot intravenous injection (of 1.5 cc/kg) of non-ionic contrast media (omnipaque /iohexol 350 mg /cc) by manual injection was performed. Two minutes after contrast administration, with erect position of the patient, a low-energy (23–32 KVp) and high-energy (45–49 KVp) pair of images were acquired within 20 s as in routine mammography (i.e.

eight exposure). Recombined iodine-enhanced images were obtained by the subtraction of low from the high-energy images, by system software.

Image Analysis and Interpretation of Contrast-Enhanced Mammography:

Image analysis was performed by two or more expert radiologists in breast imaging. All the images were evaluated on the workstation. The 2022 CEM BIRADS lexicon was used in the characterization of detected lesions in CEM. First, we will obtain 3 images (low energy, high energy and recombined).

In low energy image, the types of breast composition were assessed and categorized according to lexicon whether almost entirely fatty (type A), scattered area of glandular density (type B), heterogeneously dense (type C) or extremely dense glandular tissue (type D).

The findings on low energy image were assessed and classified into:

- Calcification which was assessed for its morphology (benign or malignant) and its distribution (diffuse, regional, grouped, linear and segmental).
- Mass which was assessed for its shape (oval, round or irregular), margins (circumscribed, not circumscribed which subdivided into irregular, or speculated). Then, if there was asymmetry or architectural distortion, which further assessed for distribution (focal, linear, segmental, regional, multiregional, or diffuse).
- Noticing that HE images not considered in the study interpretation, and the recombined images (subtracted image) was interpreted and assessment for the following were done:
- The level of background enhancement was assessed and classified into (minimal, mild, moderate and marked).
- The findings in the low energy images were assessed in recombined image whether they enhanced or not then the enhancing lesions were then classified as mass, non-mass and enhancing asymmetry as follows:
  - Enhancing mass which was also assessed for the patterns of enhancement (homogenous, heterogeneous, rim enhancement).
  - Non-mass enhancement which was further assessed for internal enhancement patterns (homogenous, heterogeneous, and clumped). And its distribution (focal, linear segmental, regional, multiregional or diffuse).

After interpretation of CEM of the referred suspicious breast lesions, the final assessment showed that the lesions either downgraded to benign or remain the same level of suspicion or upgrade to higher level of suspicion and according to the following parameters that demonstrated in Table 1 in addition, any associated findings (e.g., skin thickening or enhancement, nipple retraction or enhancement) were reported.

Table 1: The morphologic analysis and interpretation of breast lesions by contrast- enhanced mammography

Findings	BIRADS category	Lesion type	Benign finding	BIRADS category	Suspicious finding	BIRADS category
No lesion detected, or no enhancement	I	mass	Round or oval in shape with well circum- scribed margin showing homogenous enhancement	II-III	Irregular shape, irregular or speculated margins, heterogeneous or rim enhancement	IV-V
		Non mass	Distribution multi region or diffuse.		linear, segmental, focal or regional distribution especially those with clumped or heterogenous internal enhancement	
		Enhancing asymmetry	Homogenous enhancement		Heterogenous enhancement	

Dynamic contrast-enhanced MRI technique

MRI was performed using a Siemens 1.5-T MRI system. The examination was performed using bilateral sixteen channel phase array breast coils with the patient in the prone position. MR system is Siemens: MAGNETOM Aera, Erlangen, Germany). The imaging studies included localizer in the sagittal or coronal orientations. pre-contrast series include: -

1- Axial T1WI: slice thickness = 3.5 to 4 mm.

Field of view (FOV)= 400 * 400 mm. Intersection gap = 1mm. Matrix size =274 * 288.

Time repetition (TR) 426.Time to echo (TE) 4.6, flip angle 10-degree, total acquisition time =2.0 min.

2- Axial T2WI, slice thickness 4 mm, intersection gap 1 mm. FOV = 340 * 340 nm.
Matrix size 336 * 448.
TE 71 ms, TR 6000 ms, flip angle 170-degree, total acquisition time 2.33 min.

3- Axial T2WI Dixon fat and Dixon water, TR 10000 ms, TE 72 ms, slice thickness 4 mm. FOV 340 * 340 mm, intersection gap = 1mm, matrix size 448.
*44m, Flip angle 170-degree, total acquisition time 2.44 min.

4- DWI was done in axial plane at spin echo sequence using breast surface coil at the following b value (50, 400, 800 sec/mm2), slice thickness 4 mm, FOV.
= 175 *346 mm, intersection gap = 1 mm, matrix size 80 * 158, TE = 64 ms, TR 6300 ms, total acquisition time 5 min.

5- ADC map was derived automatically in the MR system.

Postcontrast Series:

Five dynamic acquisitions, one before and four after intravenous injection 0.1 cc/kg bodyweight of contrast material (Magnevist, each cc contained469 mg /cc, Dimeglumine gadopentate) using the dynamic VIBE sequence then from dynamic T1-weighted fat sat gradient-echo before and after IV gadolinium injection subtraction image were obtained as post processing reconstruction.

Image Analysis and Interpretation of Contrast-Enhanced MRI:

Image analysis was performed by expert radiologist in breast imaging. All the images were evaluated on the workstation. The 2013 MRI BIRADS lexicon was used in the characterization of detected lesions.

The finding on MRI were assessed and classified into:

- Presence or absence of enhancing lesions.
- Enhancing lesions were then classified as.
- Focus (focus is a dot of enhancement so small <5mm that it cannot be otherwise characterized; its shape and margin cannot be seen clearly enough to be described).
- Mass which was further assessed for its shape (oval, round or irregular), margins (circumscribed, not circumscribed which subdivided into irregular, or speculated). and pattern of internal enhancement (homogenous, heterogeneous, rim, dark internal septation, enhancing internal septation).
- Non-mass enhancing lesion which was further assessed for distribution (focal, linear, segmental, regional, multiregional, or diffuse), pattern of internal enhancement (homogenous, heterogeneous, clustered ring and clumped).
- Each lesion was identified also on the time–signal intensity curves were obtained on dynamic MR images by placing the region of interest at the most enhancing area of the lesion. The enhancement kinetics of each lesion were evaluated, and types of curves were determined according to delayed-phase enhancement as persistent, plateau and washout curves. Restriction of the lesion on DWI depend on ADC value which obtained by placing region of interest ROI on most enhancing part (about 3 readings taken and then average is registered) depending on many researches ADC value equal to or above 1.1x10-3 mm/sec considered non-restricted and the ADC value of 0.9 1x10-3 mm/sec and below is considered restricted. After interpretation of DCE-MRI of the referred suspicious breast lesions, the final assessment showed that the lesions either downgraded to benign or remain the same level of suspicion or upgrade to higher level of suspicion and according to the following parameters that demonstrated in Table 2 and Table 3 continuation in addition any associated findings (e.g., skin thickening or enhancement, nipple retraction or enhancement) were reported.

Table 2: The morphologic analysis and interpretation of breast lesions by contrast- enhanced MRI

Finding	BIRADS category	Lesion type	Benign finding	BIRADS category	suspicious finding	BIRADS category
No detected lesion, or no enhancement	I	Focus	High signal on T2W imaging, fatty hilum, type I curve, stable since the prior examination	II-III	Not bright on T2W imaging, no fatty hilum, type III curve, increase in size since the prior exam or new since the prior exam	IV-V
		mass	Round or oval in shape with well circum- scribed margin showing homogenous		Irregular shape, irregular or spiculated margins, heterogeneous, internal enhancing septa or thick irregular rim enhancement	

			enhancement or dark internal septation			
		Non mass	Distribution multi region or diffuse.		Linear, segmental, local or regional distribution especially those with clumped cluster or heterogenous internal enhancement	

Table 3: Continuation

Benign finding	BIRADS category	Suspicious finding	BIRADS category
Not restricted on DWI	II-III	Restricted on DWI	IV-V
Curve type I and		Curve type II -III	
Hyper SI in T1 and T2 or hypo SI in T1 and hyper SI in T2.		hypo SI in T2	

After evaluation of the suspicious breast lesions by CEM and DCE- MRI and to facilitate the statistical analysis, we divide the lesions into negative BI-RADS I, probably benign BI-RADS III, low suspicious IV a, highly suspicious of malignancy IV b - c and V.

Statistical Analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS) for Windows 26.0 software. Continuous variables were expressed as mean ± SD of the values while categorical variables were presented as percentages and frequencies. The Chi-square test or Fisher's exact test was used to test group differences of proportions. Fisher's exact test was used if one of the values in a 2 x 2 comparison is less than 5. Sensitivity, specificity, and accuracy were calculated. P-value of <0.05 was considered statistically significance.

RESULTS

A total of 30 selected suspicious breast lesions were (30 female patients). The age ranges from 24 to 70 years (meaning 47.80, SD 13.15). After correlation with final diagnosis by biopsy, the end results were benign 15/30 (50%), malignant 15/30 (50%), as illustrated in Figure 1.

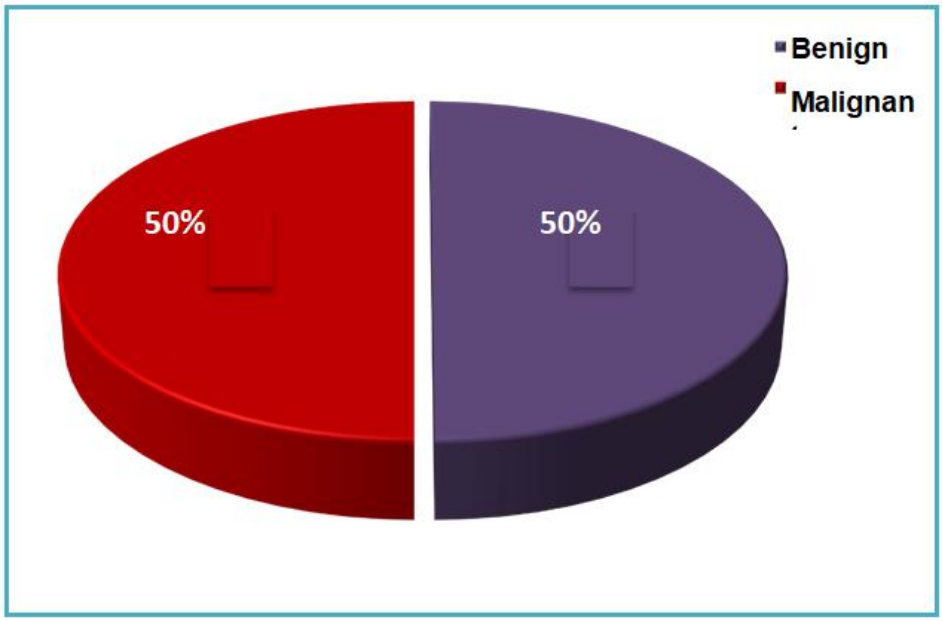

Figure 1: Histopathological result

The histopathological results of breast lesions were as following; The most frequent histopathological findings were fibroadenoma 11 (36.7%) as benign lesion, invasive ductal carcinoma 10 (33.3%) as malignant lesion. The different pathological entities are illustrated in Figure 2.

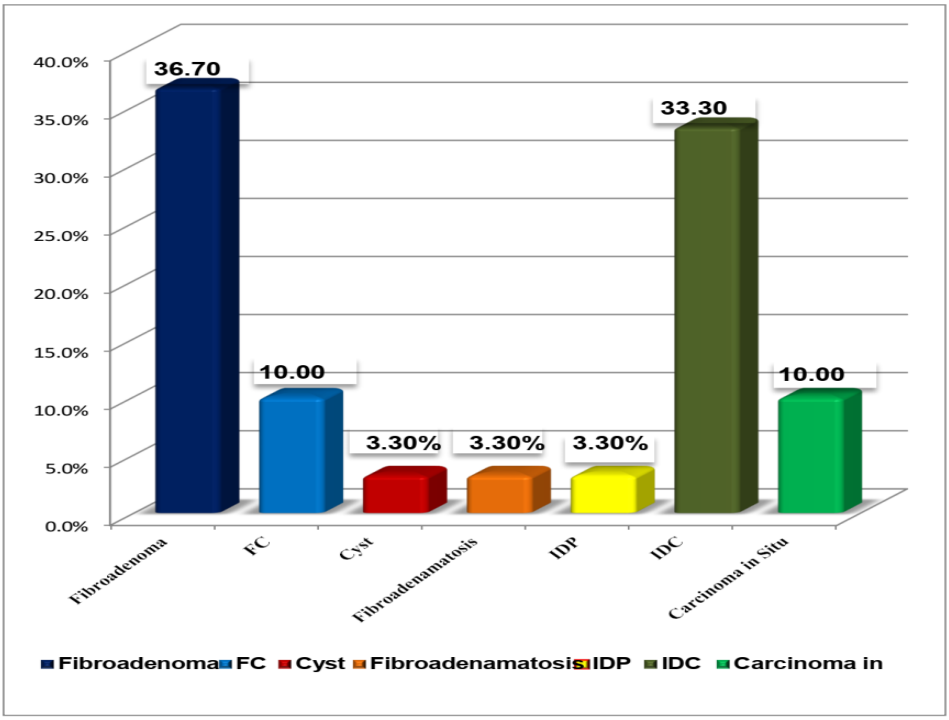

Figure 2: Pathological entities within benign or malignant groups
FC=fibrocystic, IDP=intra ductal papilloma, IDC =invasive ductal carcinoma

CEM (Contrast Enhanced Mammography) findings; regarding breast density category (using low energy image), two patient (6.7%) showed type -A, ten patients (33.3%) showed type -B and 18 (60%) showed type- C, depending on these findings; only 5/30 lesions (16.6%) were not detected in low energy image while 25 lesions (83.3%) were detected. Regarding the recombined (subtracted) images, lesions were divided into; two non-enhancing lesion (3.3%) and 28 enhancing lesions (93.3%). The two non-enhancing lesions were benign; one was fibroadenoma and the other was an infected cyst. Enhancing lesions divided into enhancing mass 20 (66.6%) and non-mass enhancement 8 (26.6%). A BI-RADS category was given for each lesion.

13 lesions (43.3%) with high suspicion (BI-RADS IVb, c and V) while 15 lesions (50%) with low suspicion (BIRADS IVa), two lesions (6.66%) were negative (BI- RADS I).

DCE-MRI (Dynamic Contrast Enhanced -MRI) 29 out of 30 lesions (96.6%) showed enhancement. The 29 enhancing lesions; were classified into enhancing mass lesion 20 (66.7%) and non -mass enhancement 9 (30%). A BI-RADS category was given for each lesion ;16/30 (53.3%) were high suspicion (BI-RADS IVb, c and V) and 6 lesions (20%**)** were low suspicions (IVa), 7(23.3%) were probably benign (BI-RADS III) and one lesion (3.33%) was negative as shown in Table (4).

Table 4: Summary of pathologic findings at contrast enhancement for all study subjects

Findings		**Contrast enhancement**			
		CEM		**MRI**	
		No.	**%**	**No.**	**%**
Detection of the lesion	Yes	28	93.3%	29	96.7%
	NO	2	6.7%	1	3.3%
Lesion Description	Mass	20	66.7%	20	66.7%
	Non-Mass	8	26.7%	9	30%
	Not detected	2	6.6%	1	3.3%
Associated features	Yes	11	36.7%	13	43.3%
	No	19	63.3%	17	56.7%
Final characterization after contrast studies (as assessment by the radiologist)	Low suspicion	15	50%	6	20%
	High suspicion	13	43.3%	16	53.3%
	Negative	2	6.66%	1	3.33%
	Probably benign	-	-	7	23.3%

Regarding mass characteristics at CEM, the most frequent pattern of enhancement was heterogeneous 15(75%) while at DCE-MRI; only 10 (50%) show heterogeneous pattern and five lesions (25%) show dark internal septa which cannot be detected on CEM, other enhancement patterns were equal between the two modalities as shown in table (3.2). Regarding the shape of the mass, there is slight difference between the two modalities regarding oval and round shape as shown in table (3.2). Regarding margin of the mass, at CEM the most frequent finding was the non-circumscribed margin 12 (60%) in comparison to DCE-MRI, the most frequent finding was circumscribed margin 11 (55%) as shown in Table (5).

Table 5: Mass characteristics at contrast enhancement for all study subjects

Findings		**Contrast enhancement**			
		CEM		**MRI**	
		No.	**%**	**No.**	**%**
Detection of the lesion	Yes	28	93.3%	29	96.7%
	NO	2	6.7%	1	3.3%
Lesion Description	Mass	20	66.7%	20	66.7%
	Non-Mass	8	26.7%	9	30%
	Not detected	2	6.6%	1	3.3%
Associated features	Yes	11	36.7%	13	43.3%
	No	19	63.3%	17	56.7%
Final characterization after contrast studies (as assessment by the radiologist)	Low suspicion	15	50%	6	20%
	High suspicion	13	43.3%	16	53.3%
	Negative	2	6.66%	1	3.33%
	Probably benign	-	-	7	23.3%

Regarding mass characteristics at CEM, the most frequent pattern of enhancement was heterogeneous 15(75%) while at DCE-MRI; only 10 (50%) show heterogeneous pattern and five lesions (25%) show dark internal septa which cannot be detected on CEM, other enhancement patterns were equal between the two modalities as shown in table (3.2). Regarding the shape of the mass, there is slight difference between the two modalities regarding oval and round shape as shown in table (3.2). Regarding margin of the mass, at CEM the most frequent finding was the non-circumscribed margin 12 (60%) in comparison to DCE-MRI, the most frequent finding was circumscribed margin 11 (55%) as shown in Table (6).

Table 6: Mass characteristics at contrast enhancement for all study subjects

Findings		**Contrast enhancement**			
		CEM (20)		**MRI (20)**	
		No.	**%**	**No.**	**%**
Pattern of mass Enhancement	Dark internal Septa	-	-	5	25%
	Homogenous	2	10%	2	10%
	Heterogeneous	15	75%	10	50%
	Rim	3	15%	3	15%
Shape of the Mass	Oval	9	45%	8	40%
	Round	2	10%	3	15%
	Irregular	9	45%	9	45%
Margin of the Mass	Circumscribed	8	40%	11	55%
	Non-Circumscribed	12	60%	9	45%

Regarding non-mass characteristics, at CEM the type of non-mass enhancement was as following; all lesions were enhanced heterogeneously, while at DCE-MRI, although the most frequent type was heterogeneous enhancement 8 (88.9%), only one lesion showed homogenous enhancement as shown in table (3.3). Regarding distribution of the non-mass lesions, there is slight difference between type of distribution, although diffuse distribution did not detect by DCE-MRI and found as regional distribution with 3 (33.3%) in compared to 1 (12.5%) on CEM, as shown in Table (7).

Table 7: Non-Mass characteristics at contrast enhancement for all study subjects

Findings		**Contrast enhancement**			
		CEM (8)		**MRI (9)**	
		No.	**%**	**No.**	**%**
pattern of Non-Mass Enhancement	Homogenous	0	-	1	11.1%
	Heterogeneous	8	100%	8	88.9%
Non-Mass Distribution	Diffuse	2	25%	-	-
	Regional	1	12.5%	3	33.3%
	Focal	2	25%	3	33.3%
	Linear	1	12.5%	1	11.1%
	Segmental	2	25%	2	22.3

On DCE-MRI, regarding diffusion; there was highly (significant) relationship between restriction and diagnosis of malignant lesions with P-value <0.001, also there was significant relationship between type of intensity curve and histopathological result as shown in Table (8).

Table 8: Other MRI Features

Findings		**Benign**		**Malignant**		**P value**
		No.	**%**	**No.**	**%**	
Diffusion	Restricted	2	14.3%	14	93.3%	**<0.001***
	Non- Restricted	12	85.7%	1	6.7%	
Type of Curve	Type I	9	64.3%	0	-	
	Type II	5	35.7%	2	13.3%	**<0.001***
	Type III	0	0.0%	13	86.7%	

***** The results are significant at P value <0.05

According to the CEM findings, taken as a whole, interpretation and a comparison with the histopathological results for each lesion, there were 14 (93.3%) true benign lesions, and 12 (80%) true malignant lesions, 3 (20%) mis-classified as benign lesions, and one (6.7%) mis-classified as a malignant as shown in Table (9).

Table 9: CEM results in relation to histopathological results among the patients

Parameters		**By histopathology**				**P-value**
		Benign		**Malignant**		
		No.	**%**	**No.**	**%**	
On CEM	Low suspicion	14	93.3%	3	20%	<0.001
	High suspicion	1	6.7%	12	80%	
	Total	15	100%	15	100%	

* The result was significant at p-value <0.05.

According to the DCE-MRI findings, taken as a whole, interpretation and a comparison with the histopathological results for each lesion, there were 14 (93.3%) true benign lesions, and 14 (93.3%) true malignant, one (6.7%) mis-classified benign lesions, and one (6.7%) mis-classified as a malignant as shown in Table (10).

Table 10: DCE-MRI results in relation to histopathological results among the patients

Parameters		**By histopathology**				**P-value**
		Benign		**Malignant**		
		No.	**%**	**No.**	**%**	
On DCE- MRI	Low suspicion	14	93.3%	1	6.7%	**<0.001***
	High suspicion	1	6.7%	14	93.3%	
	Total	15	100%	15	100%	

* The result was significant at p-value <0.05.

Aforementioned results showed that the sensitivity of CEM is equal to DCE- MRI of 93.3%, with higher specificity of DCE-MRI of 93.3% in comparison to 80% in CEM. Furthermore, there is slight difference between CEM and DCE-MRI regarding negative predictive value (NPV), 92.3 versus 93.3% consequently. While accuracy rate was higher in DCE-MRI than CEM 93.33% versus 86.67%, respectively as shown in Table (11).

Table 11: CEM in comparison to DCE-MRI study, sensitivity, specificity and accuracy rate

Statistic	CEM	MRI
Sensitivity	93.33%	93.33%
Specificity	80.00%	93.33%
Positive Predictive Value (PPV)	82.35%	93.33%
Negative Predictive Value (NPV)	92.31%	93.33%
Accuracy	86.67%	93.33%

DISCUSSION

Mammography is the only breast imaging examination shown to reduce breast cancer mortality, with a population-based sensitivity of 75% to 80%. However, the sensitivity of mammography in high-risk women with dense breasts decreased to 50% [9]. Dynamic contrast-enhanced MRI (DCE- MRI) breast has been used in the assessment of indeterminate mammographic lesions for a long time [10]. But its role is limited by high cost, long duration of examination time, and limited availability (compared to the availability of CEM) also the non-visualization of calcification [11, 12]. CEM is a relatively new imaging modality that provides both anatomic and functional information in breast lesions, similar to MRI, as they both depend on neovascularity and angiogenesis of lesions, but CEM has lower cost and examination duration time. The main disadvantage of CEM is that it lacks kinematic information about tumor enhancement [13].

Our study revealed that DCE-MRI sensitivity equals to CEM (93.33); and the NPV was almost of comparable values CEM (93.33%vs.92.31%), however, the specificity and PPV were higher in DCE-MRI than in CEM (93.33%vs.80%) and (93.33%vs.82.35%), respectively. The overall accuracy of DCE-MRI was better than that of CEM (93.33%vs 86.67%) (p =0.001).

Our findings align with several previous studies, although there are notable differences in certain metrics, which may be attributed to technical variations or reporting practices. ELfaky *et al*., [14] reported that DCE-MRI exhibited higher positive predictive value (PPV) and accuracy than CEM, with values of 96% vs. 92% and 90% vs. 86%, respectively. These results are consistent with our findings. However, in terms of negative predictive value (NPV), ELfaky *et al*., observed a significantly higher NPV for DCE-MRI (50% vs. 40%), whereas our results showed a much higher NPV for both modalities (93.33% vs. 92.31%). This discrepancy could be due to differences in DCE-MRI technical parameters and reporting protocols, which can influence the sensitivity and accuracy of the results.

Similarly, Kamal *et al*., [15] found that DCE-MRI outperformed CEM in terms of PPV (88.24% vs. 86.26%), accuracy (90.64% vs. 85.38%), and NPV (100% vs. 82.50%). Additionally, they reported that the specificity of DCE-MRI was slightly higher than that of CEM (68.67% vs. 64.71%), though this difference was not statistically significant (p = 0.67). Our study also observed a trend toward higher sensitivity for DCE-MRI compared to CEM, with values of 92.86% and 84.62%, respectively. While CEM demonstrated slightly higher specificity (88.9% vs. 87.5%), this suggests that CEM may be more effective at excluding disease, whereas DCE-MRI excels in detecting true positives, which is crucial for accurate diagnosis and treatment planning.

In contrast, Xing *et al*., [16] reported similar sensitivities for both modalities (91.5% for CEM vs. 91.5% for DCE-MRI) but found that CEM had a higher specificity (89.5% vs. 80.2%). This discrepancy can likely be attributed to the marked background enhancement observed in DCE-MRI, which may reduce its specificity by increasing the likelihood of false positives. Additionally, Łuczyńska *et al*., [17] found that CEM had slightly higher sensitivity (100% vs. 93%) and accuracy (79% vs. 73%) compared to DCE-MRI. While this difference in sensitivity was statistically significant ($p < 0.04$), the accuracy difference was not ($p = 0.29$), and CEM also exhibited a significantly higher NPV (100% vs. 65%) with a p-value of < 0.001. The large sample size (235 lesions) and extensive experience in mammographic reporting in their study could contribute to these results.

While DCE-MRI has demonstrated superior sensitivity and diagnostic accuracy, its high cost, longer imaging time, and limited availability in certain clinical settings may restrict its widespread use. In contrast, CEM, with its comparable diagnostic accuracy and higher specificity in some cases, presents a potentially more accessible and cost-effective option, particularly in resource-limited environments. Both imaging modalities have their respective advantages and limitations. DCE-MRI provides detailed tumor characterization essential for treatment planning, especially in surgical decision-making, due to its ability to assess tumor vascularity and morphology [18].

However, further studies are needed to refine the diagnostic accuracy of both techniques, especially in clinical settings where cost and accessibility are key considerations [19].

CONCLUSIONS

Contrast-enhanced mammography (CEM) has the potential to replace dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) as a problem-solving instrument for the characterization of indeterminate breast lesions, particularly in situations where MRI is contraindicated or not promptly accessible. CEM provides a viable alternative for evaluating ambiguous lesions, as it utilizes similar principles of contrast enhancement and tumor vascularity. However, it has the additional benefit of being more broadly available, less expensive, and better tolerated by specific patient populations.

REFERENCES

1. Zhu, X., Huang, J. M., Zhang, K., Xia, L. J., Feng, L., Yang, P., ... & Yu, Y. H. (2018). Diagnostic value of contrast-enhanced spectral mammography for screening breast cancer: systematic review and meta-analysis. *Clinical breast cancer*, *18*(5), e985-e995.
2. Sadeghi-Naini, A., Suraweera, H., Tran, W. T., Hadizad, F., Bruni, G., Rastegar, R. F., ... & Czarnota, G. J. (2017). Breast-lesion characterization using textural features of quantitative ultrasound parametric maps. *Scientific reports*, *7*(1), 13638.
3. Mostafa, A. A. E., Eltomey, M. A., Elaggan, A. M., & Hashish, A. A. (2019). Automated breast ultrasound (ABUS) as a screening tool: initial experience. *Egyptian Journal of Radiology and Nuclear Medicine*, *50*, 1-6.
4. BAILAR III, J. C. (1976). Mammography: a contrary view. *Annals of Internal Medicine*, *84*(1), 77-84.
5. Lourenco, A. P., & Mainiero, M. B. (2016, January). Incorporating imaging into the locoregional management of breast cancer. In *Seminars in Radiation Oncology* (Vol. 26, No. 1, pp. 17-24). WB Saunders.
6. Patel, B. K., Lobbes, M. B. I., & Lewin, J. (2018, February). Contrast enhanced spectral mammography: a review. In *Seminars in Ultrasound, CT and MRI* (Vol. 39, No. 1, pp. 70-79). WB Saunders.
7. Taylor, D. B., Kessell, M. A., & Parizel, P. M. (2024). Contrast-enhanced mammography improves patient access to functional breast imaging. *Journal of Medical Imaging and Radiation Oncology*. doi: 10.1111/1754-9485.13789.
8. Filippone, F., Boudagga, Z., Frattini, F., Fortuna, G. F., Razzini, D., Tambasco, A., ... & Carriero, A. (2024). Contrast Enhancement in Breast Cancer: Magnetic Resonance vs. Mammography: A 10-Year Systematic Review. *Diagnostics*, *14*(21), 2400. doi: 10.3390/diagnostics14212400.
9. Jochelson, M. (2012). Advanced imaging techniques for the detection of breast cancer. *American Society of Clinical Oncology Educational Book*, *32*(1), 65-69.
10. Yin, J., Yang, J., & Jiang, Z. (2019). Classification of breast mass lesions on dynamic contrast-enhanced magnetic resonance imaging by a computer-assisted diagnosis system based on quantitative analysis. *Oncology Letters*, *17*(3), 2623-2630.
11. Houssami, N., Ciatto, S., Macaskill, P., Lord, S. J., Warren, R. M., Dixon, J. M., & Irwig, L. (2008). Accuracy and surgical impact of magnetic resonance imaging in breast cancer staging: systematic review and meta-analysis in detection of multifocal and multicentric cancer. *Journal of Clinical Oncology*, *26*(19), 3248-3258.
12. Roganovic, D., Djilas, D., Vujnovic, S., Pavic, D., & Stojanov, D. (2015). Breast MRI, digital mammography and breast tomosynthesis: comparison of three methods for early detection of breast cancer. *Bosnian journal of basic medical sciences*, *15*(4), 64-68.
13. Nekhlyudov, L., Kiarsis, K., & Elmore, J. G. (2009). MRI of the breast: does the internet accurately report its beneficial uses and limitations?. *The breast journal*, *15*(2), 189-193.
14. Fallenberg, E. M., Schmitzberger, F. F., Amer, H., Ingold-Heppner, B., Balleyguier, C., Diekmann, F., ... & Dromain, C. (2017). Contrast-enhanced spectral mammography vs. mammography and MRI–clinical performance in a multi-reader evaluation. *European radiology*, *27*, 2752-2764.
15. Kamal, R. M., Helal, M. H., Wessam, R., Mansour, S. M., Godda, I., & Alieldin, N. (2015). Contrast-enhanced spectral mammography: Impact of the qualitative morphology descriptors on the diagnosis of breast lesions. *European journal of radiology*, *84*(6), 1049-1055.
16. Xing, D., Lv, Y., Sun, B., Xie, H., Dong, J., Hao, C., ... & Chi, X. (2019). Diagnostic value of contrast-enhanced spectral mammography in comparison to magnetic resonance imaging in breast lesions. *Journal of Computer Assisted Tomography*, *43*(2), 245-251.
17. Łuczyńska, E., Heinze-Paluchowska, S., Hendrick, E., Dyczek, S., Ryś, J., Herman, K., ... & Jakubowicz, J. (2015). Comparison between breast MRI and contrast-enhanced spectral mammography. *Medical science monitor: international medical journal of experimental and clinical research*, *21*, 1358.
18. Rezaei, S., & Rad, H. S. (2014). A Review Study on the efficacy of Quantitative DCE-MRI in Adnexal Lesion Diagnosis. *Iranian Journal of Radiology*, 11. doi: 10.5812/IRANJRADIOL.21252.
19. Taylor, D. B., Burrows, S., Dessauvagie, B. F., Saunders, C. M., & Ives, A. (2023). Accuracy and precision of contrast enhanced mammography versus MRI for predicting breast cancer size: how “good” are they really?. *The British journal of radiology*, *96*(1144), 20211172. doi: 10.1259/bjr.20211172.