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Contrast enhanced mammography in breast lesions with BI-RADS 4 and 5

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Abstract
Background: The radiological field of breast imaging is currently undergoing a new technological shift to improve breast cancer detection. Contrast-enhanced spectral mammography helps to overcome the limitations of conventional mammography.
Aim: To evaluate the role and validity of contrast-enhanced spectral mammography in the detection and characterization of breast suspicious lesions.
Patients and Method: A prospective study was conducted in Oncology Teaching Hospital in Iraq during the period from October 2022 to October 2023. The sample included 50 patients with BI-RADS categories 4 and 5. Those patients underwent Contrast-enhanced spectral mammography examinations. The final confirmed diagnosis was obtained by histopathological analysis by core biopsy or surgery.
Results: According to histopathological examination, 33 (66%) of the patients were diagnosed with malignant lesions and 17 (34%) of them were diagnosed with benign lesions. The sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of contrast-enhanced spectral mammography in predicting malignant lesions were 93.8%, 83.3%, 90.9%, 88.2%, and 90%, respectively.
Conclusion: Contrast-enhanced spectral mammography is a feasible and accurate imaging technique for the detection and characterization of breast suspicious lesions and assessment of the extent of cancerous breast lesions.

Keywords: CESM, breast mass, contrast enhancement, accuracy

Introduction

Lesions in the breast are categorized as either benign or malignant [1]. Benign breast lesions are typically considered to be masses that do not grow, masses that are proliferative, or masses that have atypia. The probability of subsequent breast cancer is higher in masses that are proliferative than in masses that are non-proliferative, the risk is also higher in atypical proliferative masses [2]. Breast cancer is composed of a variety of masses that have a diverse clinical presentation, morphology, molecular composition, biological behavior, and response to treatment [3]. It's segregated into two varieties: Invasive cancer, which involves the cancer cells penetrating the ducts and lobules in order to invade the surrounding tissues in the breast, and non-invasive cancer (also known as in situ), which involves the cancer cells only growing in the ducts and lobules [4, 5]. Mammography is a specialized form of radiography that visualizes the breast using X-ray technology. Its objectives are first to recognize breast cancer early on, before the symptoms appear (Screening Mammography), and second, to diagnose patients with symptoms (Diagnostic Mammography, also known as Clinical Mammography) [6, 7]. Contrast-enhanced Spectral Mammography (CESM) is derived from a dual-energy K-edge subtraction imaging method. It's an imaging method that employs contrast-enhanced combined images to assess neovascularity. It amalgamates conventional mammography with contrast material that is iodinated in order to enhance the detection of cancer [8, 9]. Clinical uses of CESM include those that are currently approved for use on MRI as both methods are derived from mass and non-mass enhancement, the potential clinical applications of CESM include problem-solving for ambiguous findings on screenings of mammography, the evaluation of the symptomatic patient, the preoperative assessment of the disease's extent, the response to neoadjuvant therapy, the evaluation of the posttreatment breast, and screening in patients with intermediate or high risk [10].

Aim of the study: To evaluate the role and validity of contrast-enhanced spectral mammography in the detection and characterization of breast suspicious lesions.

Patients and Method

Study design and setting: A prospective study was conducted in Oncology Teaching Hospital / Baghdad Medical City / Iraq during the period from October 2022 to October 2023.

Sampling method: A convenient sample of 50 patients who came to the Radiology Department for Breast Imaging and met the inclusion criteria was enrolled in the current study. The inclusion criteria included patients with BI-RADS categories 4 and 5 who were contraindication to magnetic resonance imaging. The exclusion criteria included patients with elevated blood urea and/or serum creatinine, allergic reactions to iodinated contrast agents, and pregnant women. BI-RADS is a classification system proposed by the American College of Radiology (ACR) [11].

Data collection: The gathered data included the signs and symptoms of the present illness including pain, nipple discharge, and ulceration. The mammogram was performed using digital mammography including four views of routine cranio-caudal and mediolateral oblique views of the breast and spot views when needed. The included patients underwent CESM examinations using a Senographe Pristine GE healthcare full-field digital mammography machine. We evaluated the presence or absence of enhancement and define the enhancement descriptors for each lesion. The final confirmed diagnosis was obtained by histopathological analysis by core biopsy or surgery. These were used as the gold standard.

Statistical analysis: The data was entered and analyzed by the Statistical Package of Social Science, version 22. Continous data was presented as mean ±standard deviation (SD). Categorial data were presented as frequencies. The study groups were compared by the Chi-Square test for statistical differences. A P-value less than or equal to 0.05 was considered statistically significant.

Results

A total of 50 were enrolled in the current study. According to histopathological examination, 33 (66%) of the patients were diagnosed to have malignant lesions and 17 (34%) of them were diagnosed to have benign lesions.

Patients with benign lesions had a significantly higher incidence of pain compared to those with malignant lesions (P-value=0.019). Patients with malignant lesions had a significantly higher incidence of mass (P-value=0.041), skin changes (P-value=0.017) and nipple retraction (P-value = 0.020) compared to those with benign lesions. As shown in table 1.

Table 1: Clincal prsentations of the patients

Clinical presentation		Begin lesions (N=17)	Malignant lesions (N=33)	Total N (%)	P-value
Mass	Yes	10 (58.9)	28 (84.8)	38 (76.0)	0.041
	No	7 (41.1)	5 (15.2)	12 (24.0)	
Pain	Yes	7 (41.2)	4 (12.1)	11 (22.0)	0.019
	No	10 (58.8)	29 (87.9)	39 (78.0)	
Skin changes	Yes	2 (11.8)	15 (45.5)	17 (34.0)	0.017
	No	15 (88.2)	18 (54.5)	33 (66.0)	
Nipple discharge	Yes	4 (2.35)	5 (15.2)	9 (18.0)	0.465
	No	13 (76.5)	28 (84.8)	41 (82.0)	
Nipple retraction	Yes	1 (5.9)	12 (63.4)	13 (26.0)	0.020
	No	16 (94.1)	21 (63.6)	37 (74.0)	

Among patients who had malignant lesions, 13 (39.4%) patients had ductal carcinoma in situ, 8 (24.2%) had invasive lobular carcinoma, 8 (24.2%) had invasive ductal carcinoma, and 2 (6.1%) had lobular carcinoma in situ. Among patients with benign lesions, the highest proportion of them 6 (35.4%) had fibroadenoma. As shown in figure 1.

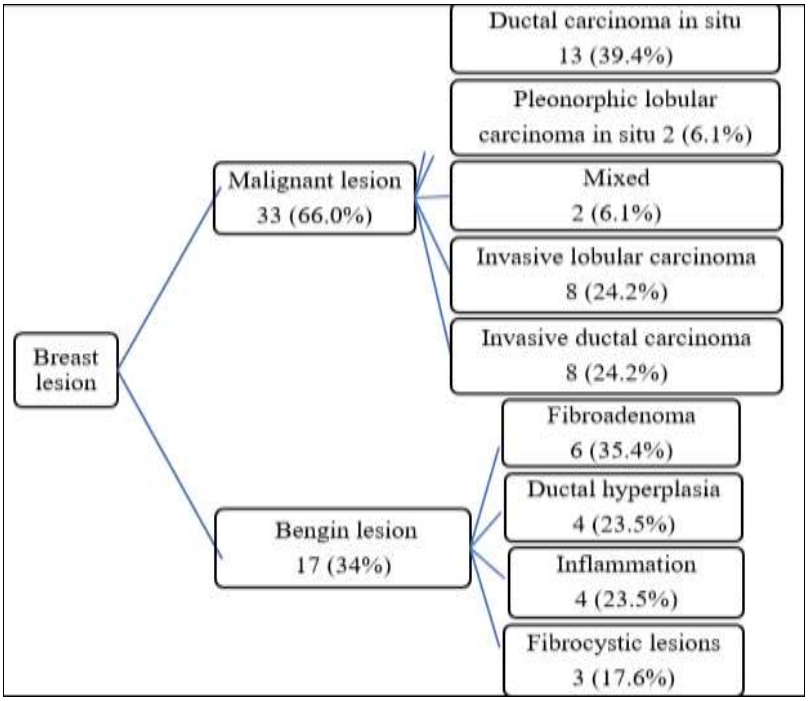


Fig 1: Distribution of the patients according to the types of malignant and benign lesions

Regarding the characteristics of contrast enhancement, 35 (70%) patients had mass enhancement and 15 (30%) had non-mass enhancement. Among patients with mass enhancement, 30 patients had malignant lesions and 5 patients had benign lesions according to the histological results. Among patients with non-mass lesions, 12 patients had benign lesions 3 patients had malignant lesions according to the histological results. As shown in table 2.

Table 2: Characteristics of the contrast enhancement

Characteristics			Benign (N %)	Malignant N (%)	Total N (%)
Mass enhancement			**5**	**30**	**35**
Morphology	Shape	Round	2 (40.0)	4 (13.3)	6 (17.1)
		Oval	3 (60.0)	2 (6.7)	5 (14.3)
		Irregular	0 (0.0)	24 (80.0)	24 (68.6)
	Margin	Circumscribed	3 (60.0)	11 (36.7)	14 (40.0)
		Non- circumscribed	2 (40.0)	19 (63.3)	21 (60.0)
Internal enhancement	Homogenous		2 (40.0)	2 (6.7)	4 (11.4)
	Heterogenous		3 (60.0)	13 (43.3)	16 (45.7)
	Rim		0 (0.0)	15 (50.0)	15 (42.9)
Extent of enhancement	Partially enhances		3 (60.0)	5 (16.7)	8 (22.9)
	Completely enhances		2 (40.0)	16 (53.3)	18 (51.4)
	Extended beyond lesion		0 (0.0)	9 (30.0)	9 (25.7)
	Enhancement of the adjacent tissue without enhancement		0 (0.0)	0 (0.0)	
Conspicuity	Low		3 (60.0)	4 (13.3)	7 (20.0)
	Moderate		1 (20.0)	7 (23.3)	8 (22.9)
	High		1 (20.0)	19 (63.4)	20 (57.1)
Non-mass enhancement			12	3	15
Distribution	Diffuse		1 (8.3)	2 (66.7)	3 (20.0)
	Multiple regions		2 (16.7)	1 (33.3)	3 (20.0)
	Regional		5 (41.6)	0 (0.0)	5 (33.4)
	Focal		2 (16.7)	0 (0.0)	2 (13.3)
	Linear		0 (0.0)	0 (0.0)	0 (0.0)
	Segmental		2 (16.7)	0 (0.0)	2 (13.3)
Internal enhancement	Homogenous		1 (8.3)	1 (33.3)	2 (13.3)
	Heterogenous		8 (66.7)	2 (66.7)	10 (66.7)
	Clumped		3 (25.0)	0 (0.0)	3 (20.0)
Extent of enhancement	Partially enhances		9 (75.0)	0 (0.0)	9 (60.0)
	Completely enhances		2 (16.7)	3 (100.0)	5 (33.4)
	Extended beyond lesion		1 (8.3)	0 (0.0)	1 (6.6)
	Enhancement of the adjacent tissue without enhancement		0 (0.0)	0 (0.0)	0
Conspicuity	Low		3 (25.0)	1 (33.3)	4 (26.7)
	Moderate		7 (58.3)	2 (66.7)	9 (60.0)
	High		2 (16.7)	0 (0.0)	2 (13.3)

Compared to histopathological examination, the sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of CESM in predicting malignant lesions were 93.8%, 83.3%, 90.9%, 88.2%, and 90%, respectively (Table 3).

Table 3: Validity of CESM in predicting breast malignancy

		CESM		P-value
		Malignant lesions N (%)	**Benign Lesions N (%)**	
Histological examination	Malignant lesions	30 (93.8)	3 (16.7)	0.001
	Benign lesions	2 (6.3)	15 (83.3)	
Sensitivity		93.8%		
Specificity		83.3%		
Positive predictive value		90.9%		
Negative predictive value		88.2%		
Accuracy		90%		

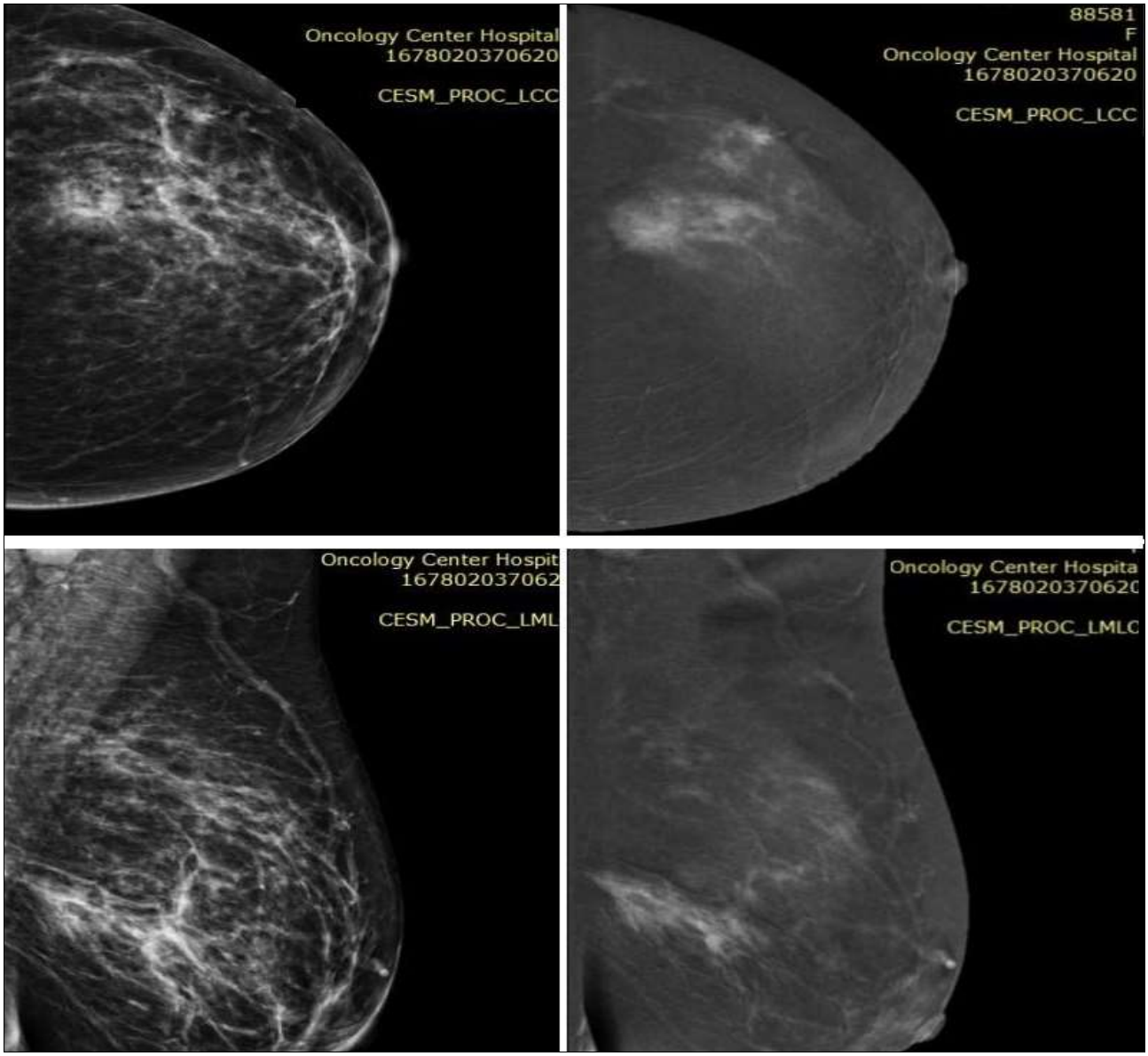
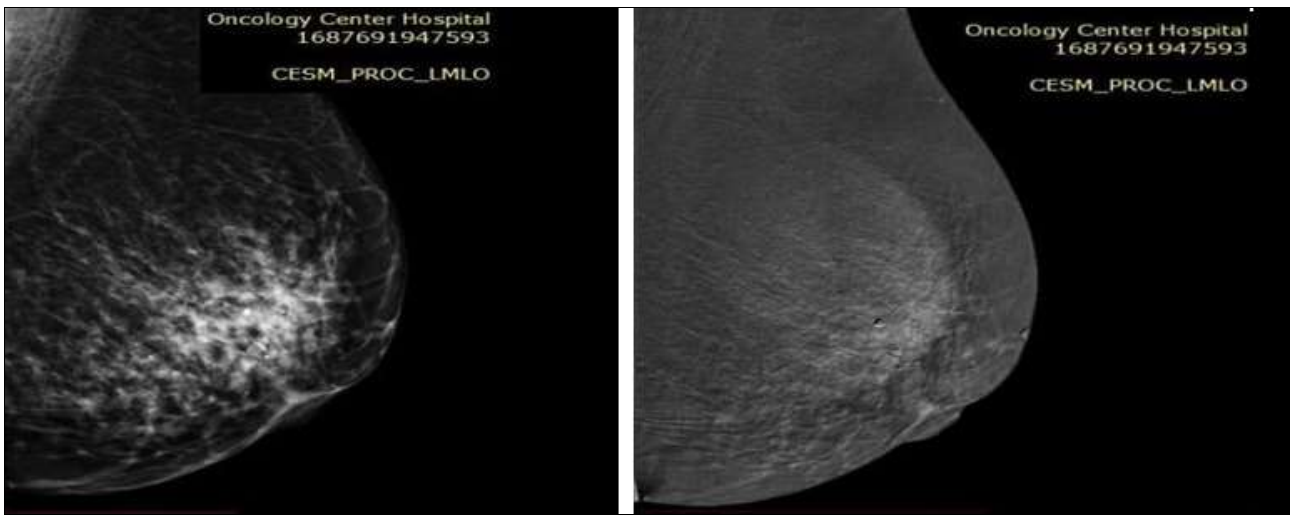


Fig 2: Left breast CESM of 54-years-old female: Heterogenous, fibroglandular tissue with global asymmetry at the upper outer quadrant, middle, and posterior third with architectural distortion: CESM shows segmental heterogenous non-mass enhancement (5.5cm x 7.5cm) with high conspicuity occupying lesion, the enhancement does not extend beyond the lesion. Multiple suspicious enhancing axillary lymph nodes: Histopathological examination revealed invasive ductal carcinoma



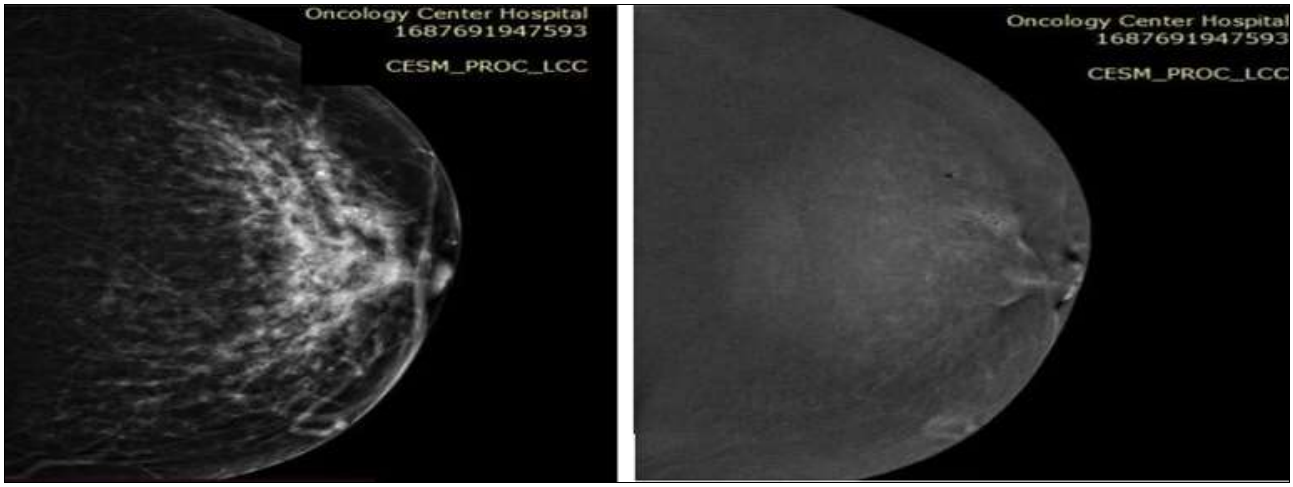


Fig 3: Left breast CESM of 32-years-old female: Low energy image shows scattered fibroglandular breast tissue: there is global asymmetrical density in the retro areolar region in the upper outer quadrant associated with a coarse heterogeneous needle-like calcification in a segmental distribution. CESM shows heterogenous focal non-mass enhancement with moderate conspicuity, the enhancement does not extend beyond the lesion. Histopathological examination revealed fibrocystic disease with ductal ectasia

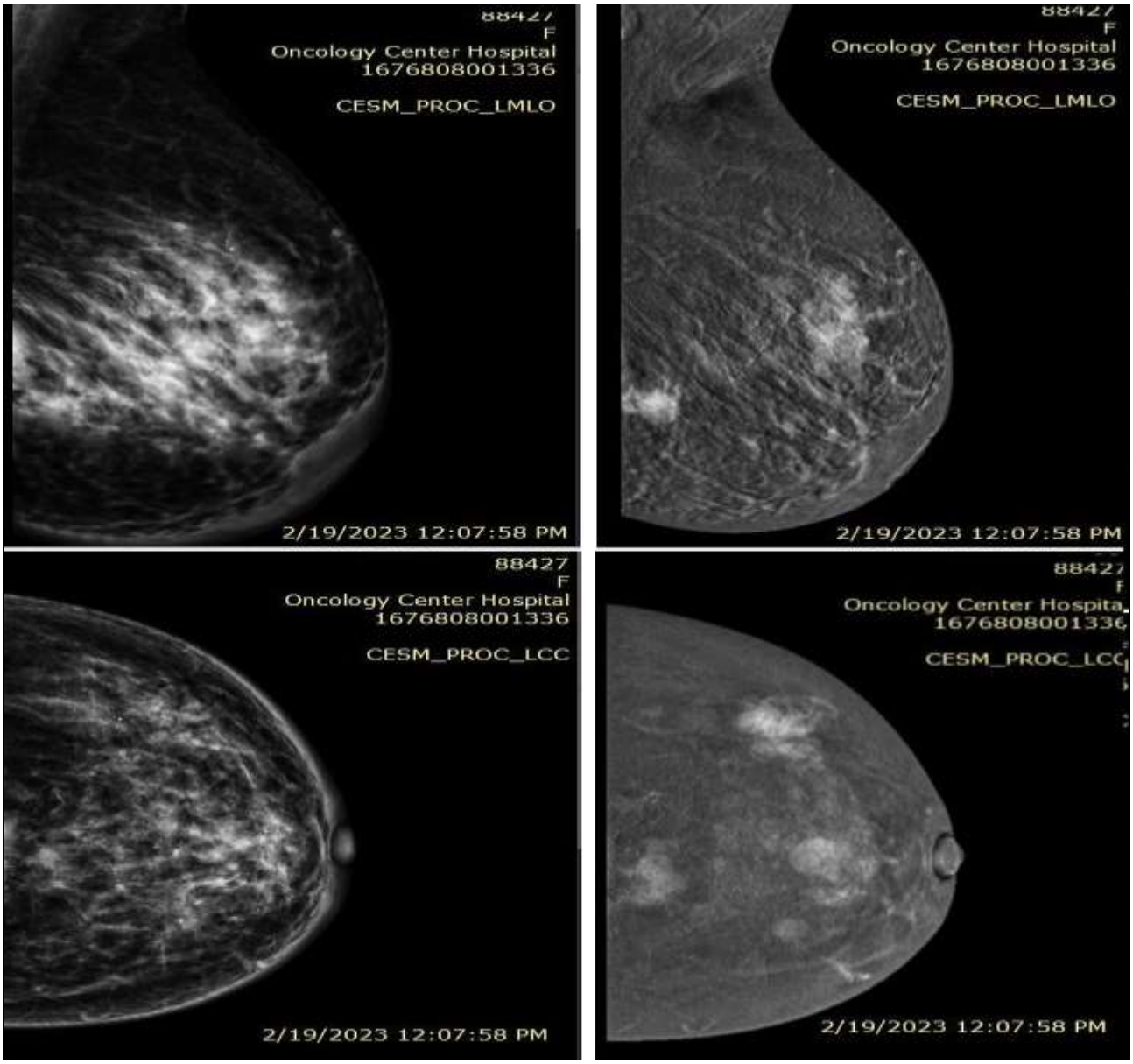


Fig 4: Left breast CESM of 35-years-old female: Heterogenous fibroglandular tissue with global asymmetry at left breast especially at the posterior third retrommamary region. there are multiple multicentric variable-sized heterogenous enhancing masses and also heterogenous focal non-mass enhancement seen with high conspicuity. the enhancement does not extend beyond the lesion. There are suspicious lymph nodes are seen. Histopathological examination of invasive ductal carcinoma.

Discussion

Malignant and benign diseases are very common in the breast. Aside from clinical history and breast examination, imaging procedures and especially mammography are of crucial importance in the detection and diagnosis of breast cancer and other breast diseases [6, 7]. This study was one among others that tried to assess the validity of ECSM in the detection of malignant breast lesions among those who present with suspicious breast lesions. The proportion of patients who had skin changes and nipple retraction was significantly higher among patients with malignant lesions compared to those with benign lesions while the proportion of patients who had pain was significantly lower among patients with malignant lesions compared to those with benign lesions. In addition, no significant difference was obtained regarding the nipple discharge. The same results were obtained in another study that was done by Haria *et al*. as the skin changes and nipple retraction were significantly associated with malignant lesions while the pain was significantly associated with benign lesions [12]. In agreement, Babatunde *et al*. reported that breast pain is usually associated with benign breast disease. Even so, their study revealed that breast pain was a statistically significant presentation in patients with malignant breast disease and this might be due to that the patients in their study were at advanced stages of malignancy [13]. In the current study, 66% of the patients had malignant lesions according to the histopathological examination. The same results were obtained in another study that was done by Elżbieta *et al*. as 69% of the patients with breast lesions who were enrolled had malignant lesions [14]. In another study that was done by Haria *et al*., the patients who were diagnosed with malignant lesions by histopathological examination constituted 52% of the sample [12]. In another study that was done by Omnia Mokhtar and Sheryhan Mahmoud, out of 60 women with suspected findings on mammography and/or ultrasound, 44 (73%) had malignant lesions according to the histopathological examination [15]. Among patients with malignant lesions, more than two-thirds had ductal carcinoma in situ, followed by invasive lobular carcinoma and invasive ductal carcinoma. This agreed with the results of another study that was done by Elżbieta *et al*. as most patients with malignant lesions had invasive lesions [14]. In another study that was done by Miki *et al*., 62% of the patients with malignant lesions had invasive ductal carcinoma and 38% had Ductal carcinoma in situ [16]. Invasive ductal carcinoma was the most common finding among patients with malignant breast mass in another study that was done by Vera *et al*.[17]. Among patients with benign lesions, a higher proportion of patients had fibroadenoma followed by ductal hyperplasia. In agreement, a higher proportion of patients with benign lesions had fibroadenoma, followed by fibrosclerosis, fibrocystic masses, and radial scar as revealed in another study that was done by Elżbieta [14]. In comparison, another study that was done by Vera *et al*. revealed that the higher proportion of patients with benign lesions had fibroadenoma, followed by fibrocystic changes, adenosis, and ductal hyperplasia [17]. Fibroadenoma was the commonest diagnosis of benign breast CESM in another study that was done by Babatunde *et al*. [13]. In the current study, most patients with mass enhancement had malignant lesions in histological examination and most of those with non-mass enhancement had benign lesions. In comparison, the same results were obtained in another study that was done by Geunwon*et al*. which revealed that 104 patients out of 190 patients with mass enhancement had malignant lesions while only 5 patients out of 181 patients with non-mass enhancement had malignant lesions [18]. This agreed with the results of another study that was done by Ying *et al*. who concluded that the proportion of non-enhancement lesions was higher in the benign lesions than in the malignant lesions [19]. In another study that was done by Akmaral *et al*., all the malignant lesions had had mass enhancement while only 33% of the benign lesions had mass enhancement [20]. Compared to the histopathological examination, the current study revealed that the sensitivity, specificity, and accuracy of the CESM were 93.8, 83.3%, and 90%, respectively. In another study that was done by Vera *et al*., the sensitivity and specificity of CESM were 90.3% and 76.1%, respectively [17]. While the sensitivity and specificity were 92% and 74.4%, respectively in another study that was done by Sandy *et al*. [21], 86.2% and 94.1%, respectively in the study that was done by Miki *et al*. [16], and 100% and 79%, respectively in the study that was done by Elżbieta *et al*. [14].

Conclusion

CESM is a practical and accurate imaging method for the detection and description of suspicious breast lesions. CESM is appropriate for the evaluation of the size of cancerous breast lesions. The sensitivity, specificity, and accuracy of CESM in predicting cancerous lesions was 93.8%, 83.3%, and 90%, respectively.

Conflict of Interest

Not available

Financial Support

Not available

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