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Role of Isotope Scan and CT in Evaluation of Palpable Breast Carcinoma in Comparison to Routine Imaging

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Abstract

Background: The diagnosis of breast cancer requires sensitive and specific examinations to detect the lesion and avoid surgical intervention in benign lesions. Moreover, therapeutic planning requires accurate preoperative evaluation of tumor extent and detection of multicentric and multifocal lesions.

Aim of Study: This study aimed to assess the diagnostic accuracy of CT and Isotope scan in detection of breast cancer and their metastatic lesions.

Patients and Methods: This study included 38 female patients who were referred from Oncology Center of Mansoura University and Outpatient Surgery Clinic based on physical finding of palpable breast masses. All patients underwent clinical history and examination, Ultrasound and mammography, Contrast enhanced CT, Isotope scan and SPECT / CT fusion technique if available.

Results: Contrast enhanced CT, mammography, and US are 100% specific for diagnosis of malignant mass but they differ in their sensitivity that was 88% for mammography, 97% for US and 100% for post-contrast CT. Comparison of the area under the ROC curve of the perfect post-contrast CT versus the two other modalities revealed that the difference was statistically significant when comparing it with mammography (p=0.0351) but it was not statistically significant when comparing it with US (p=0.2787).

Conclusions: CT mammography proved high efficacy in detection of solitary primary and bilateral masses. It has the advantage of wide images scope to detect LNs as well as other skin and chest wall lesions. We indicated in our study to do bone scan and whole body CT for all patients of breast cancer as combination between them which proved highly sensitivity and specificity in detection of primary breast masses as well as metastatic lesions.

Key Words: *Isotope Scan – CT – Palpable Breast Carcinoma Routine Imaging.*

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Introduction

BREAST cancer is the most common malignancy in women worldwide with more 370,000 deaths per year. It is the second leading cause of cancer deaths among women with 20-59 years old **[1,2]**.

The diagnosis of breast cancer requires sensitive and specific examinations to detect the lesion and avoid surgical intervention in benign lesions. Moreover, therapeutic planning requires accurate preoperative evaluation of tumor extent and detection of multicentric and multifocal lesions **[3]**.

Conventional mammography and ultrasonography (US) of the breast are routinely used as imaging technique in the diagnosis of breast cancer worldwide **[4]**. The addition of magnetic resonance imaging (MRI) or computed tomography (CT) examination to conventional breast studies with mammography and ultrasonography has become more common and widely used for evaluation of breast lesions **[4,5]**.

Although mammography is the current standard for breast cancer screening; it has the drawback of the superimposition effect found in projection imaging where overlying normal breast tissue can obscure a lesion, thereby hindering detection, or it can cause summation artifact leading to false-positive results, recalls, and additional studies as a fully tomographic modality, breast CT may improve the detection and diagnosis of breast cancer. **[8]**.

CT mammography has been shown to have high diagnostic efficacy in evaluation of breast cancer is especially important in patients who

cannot undergo MRI because of contraindications such as claustrophobia [9]. Compared with MRI the advantage of dynamic CT mammography is a shorter acquisition time. A complete study can be performed in one breath-hold with good spatial and contrast resolution due to the strong contrast enhancement of the surrounding fat tissue. One of the most important advantages of MDCT is thin collimation which improves multiplanner and 3D reconstructions [3].

SPECT has proved more sensitive than planar imaging in various clinical settings because of better special resolution in particular, in the detection rate of smaller lesions. This issue is of the most importance the ability to visualize small breast cancers is crucial for the development and acceptance of scintimammography, because other breast imaging modalities (mammography, MRI) permit an early detection of small lesions [11].

SPECT-CT is a potential new tool for LN localization and radioguided surgery in the coming years especially in patients with extra-axillary SLN location and non-visualization [11].

This study aimed to assess the diagnostic accuracy of CT and Isotope scan in detection of breast cancer and their metastatic lesions.

Patients and Methods

This study included 38 female patients with breast cancer and metastasis. Their ages ranged from 39 to 69 years old, mean age 54 years. It was conducted at the Radiology Department of Mansoura University Hospital (25 cases-65%) and private center (13 cases-35%) over the period from April 2016 to December 2018. All patients were referred from Oncology Center of Mansoura University and Outpatient Surgery Clinic based on physical finding of palpable breast masses. The reported diagnosis was confirmed by histopathology of specimens obtained by excision biopsy (15 cases -39%), core biopsy (19 cases- 50%), or fine-needle aspiration (4 cases-11%). Our institution's ethics committee approved the study, and all patients gave their informed consent before inclusion in the study.

Inclusion criteria were Female patients with palpable breast cancer. Patients with breast mass detected on mammography or sonography. Patients with breast lesion detected by US who are known to be unsuitable to undergo MRI (claustrophobia, peace maker, metallic prosthesis). Must agree to participate in the study.

Exclusion criteria were bad general condition and uncooperative patients, pregnant female, elevated serum creatinine and hypersensitive to contrast media.

All the patients were subjected to:

I- Full history and Clinical examination.

II- Radiological investigation in the form of Sono-Mammography, CT & Isotope scan:

1- Mammography and complementary ultrasound:

Mammography was done for all patients, Cranio-caudal (CC) and medio-lateral oblique (ML) projections were done for all patients. Breast ultrasound examination was done using high frequency probe as a complementary method for the mammographic findings.

2- Contrast Enhanced CT.

3- Patient preparation:

We explained the procedure to the patients then Creatinine analysis was done to all patients to make sure that they don't have chronic kidney disease. Contrast injection: Administration of 100mL of non-ionic iodinated contrast media (350mg/ml) was injected through antecubital vein in all pateints, using a mechanical power injector at a rate of 2.0-3.0mL/sec. CT imaging interpretation: Morphological assessment: A lesion is classified as a mass or non-mass-like enhancement. Mass: A mass is a three-dimensional, space occupying lesion measuring 5mm. It is usually v sible on pre-contrast study. Masses are evaluated regarding the following criteria: (a) Shape: Rounded, ovoid, lobulated or irregular. (b) Margins: Smooth, irregular, or speculated. (c) Internal enhancement characteristics: Enhancement patterns. Of masses have been divided: Homogeneous enhancement, Heterogeneous enhancement, Rim enhancement, enhancing internal septations, Central enhancement. Non-mass enhancement: non-mass-like enhancement refers to enhancement of an area that is not a mass. There is no space-occupying effect, and the lesion is not identified on non-enhanced study. For metastatic workup: Different appearance of each organ in examination; from brain, chest, liver, bone, pelvis & lymph nodes.

4- Isotope Scan:

Patient preparation for isotope bone scan: Bone scan requires no special preparation. Before the scan, we asked patients to take off jewelry with metal, including body piercings. Isotope bone scan and its images: Bone scintigraphy was performed by the intravenous administration of technetium-99m diphosphonate at a dose of 20mCi. Images

were obtained after 4h on a gamma camera (SMV, Brussels, Belgium). Anterior and posterior views of the whole body were acquired. The bone scan was interpreted by the nuclear medicine staff (agreement between two reviewers).

Statistical analysis:

Statistical analysis was done by SPSS v27 (IBM©, Chicago, IL, USA). Shapiro-Wilks test and histograms were used to evaluate the normality of the distribution of data. Quantitative parametric data were presented as mean and standard deviation (SD) and were analysed by unpaired student *t*-test. Quantitative non-parametric data were presented as median and interquartile range (IQR) and were analysed by Mann Whitney-test. Qualitative variables were presented as frequency and percentage (%) and were analysed utilizing the Chi-square test or Fisher's exact test when appropriate. Receiver Operating Characteristic curve (ROC-curve) analysis was performed. A two tailed *p*-value <0.05 was considered statistically significant.

Results

This study involved 38 female patients with a mean age (years) ± SD equals 54±15. 1.

Table (1) showed that irregular shape, speculated margin and micro-calcifications have the highest PPV for malignancy, with all cases having the previously noted criteria being malignant in our study.

Of these 4 diagnostic features, only 2 were statistically significant in diagnosing malignancy; namely, speculated margin (p=0.037) & irregular shape (p=0.037) while the other 2 features did not reach a statistical significance to diagnose malignancy; namely, heterogeneous enhancement (p= 0.130) & rim enhancement (p=0.705). (Table 2).

This table showed that all three modalities are 100% specific for diagnosis of malignant mass but they differ in their sensitivity that was 88% for mammography, 97% for US and 100% for post-contrast CT. We conclude that depending on morphological criteria of the lesion alone without addition of enhancement criteria sensitivity of MDCT was 86.8%, specificity was 100%, PPV was 100% and NPV was 50%.

A case of female patient aged 64 years old with right breast mass under hormonal treatment. No operative history. She underwent core biopsy and her pathology was invasive ductal carcinoma (Fig. 1).

Among the studied cases we found that most common sites of breast cancer metastasis were lymphatic and bony skeleton about (75%), the second common site was chest (lung) metastasis in about (50%), the third site was liver in about (40%). Only (5%) show special sites of metastasis like brain and ovaries. (Fig. 2).

Table (1): Morphological criteria of the mass detected by contrast enhanced MDCT.

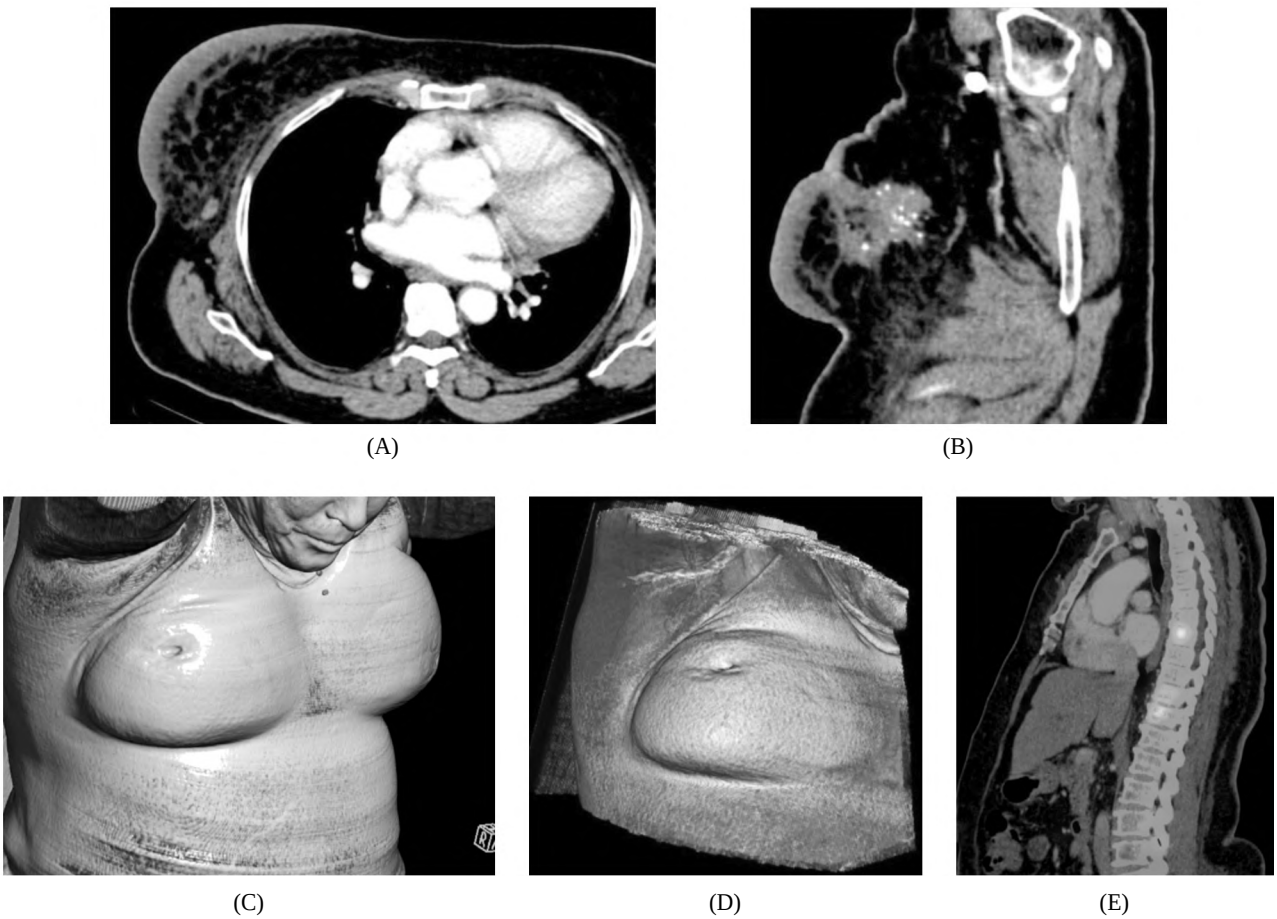
Feature	Total	Benign (n=5)	Malignant (n=35)	PPV for malignancy
Shape:				
Irregular	22 (55%)	0	22	100%
Oval	3 (7.5%)	3	0	0%
Rounded	3 (7.5%)	1	2	66.6%
Lobulated	12(30%)	1	11	91.6%
Margin:				
Circumscribed	6 (15%)	5	1	16.6%
Irregular	12 (30%)	0	12	100%
Speculated	22 (55%)	0	22	100%
Calcifications:				
No	37 (92.5%)	5	32	86.5%
Grouped micro-calcifications	2 (5.0%)	0	2	100%
Segmental micro-calcifications	1 (2.5%)	0	1	100%

Table (2): Diagnostic accuracy of contrast enhanced CT features for prediction of malignancy in breast lesions.

Feature	AUC (95% CI)	Sensitivity	Specificity	PPV	NPV
Speculated margin	0.91 (0.78-0.97)	22/27 (81.5%)	16/16 (100%)	22/22 (100%)	16/21 (76.2%)
Irregular shape	0.91 (0.78-0.97)	22/27 (81.5%)	16/16 (100%)	22/22 (100%)	16/21 (76.2%)
Heterogeneous enhancement	0.71 (0.55-0.84)	16/38 (42.1%)	05/05 (100%)	16/16 (100%)	05/27 (18.5%)
Rim enhancement	0.55 (0.39-0.70)	04/38 (10.5%)	05/05 (100%)	04/04 (100%)	05/39 (12.8%)

Table (3): Diagnostic accuracy of contrast enhanced CT, mammography, and US in diagnosing malignant mass.

Test	AUC (95% CI)	Sensitivity	Specificity	PPV	NPV
Mammography (n=42 masses)	0.88 (0.74-0.96)	29/38 (76.3%)	4/4 (100%)	29/29 (100%)	4/13 (30.8%)
US (n=43 masses)	0.97 (0.87-1.00)	36/38 (94.7%)	5/5 (100%)	36/36 (100%)	5/7 (71.4%)
MDCT (n=43 masses)	1 (0.92-1.00)	38/38 (100%)	5/5 (100%)	38/38 (100%)	5/5 (100%)



(A) (B) (C) (D) (E)

Fig. (1): (A,B): Axial and sagittal CECT showed heterogeneous speculated right retro-areolar breast mass with multiple clusters of calcifications. (C,D): Coronal VRT clearly demonstrates the skin retraction and peau d'orange. (E): Sagittal SPECT-CT displaying the active tracer uptake of bony metastatic lesions.

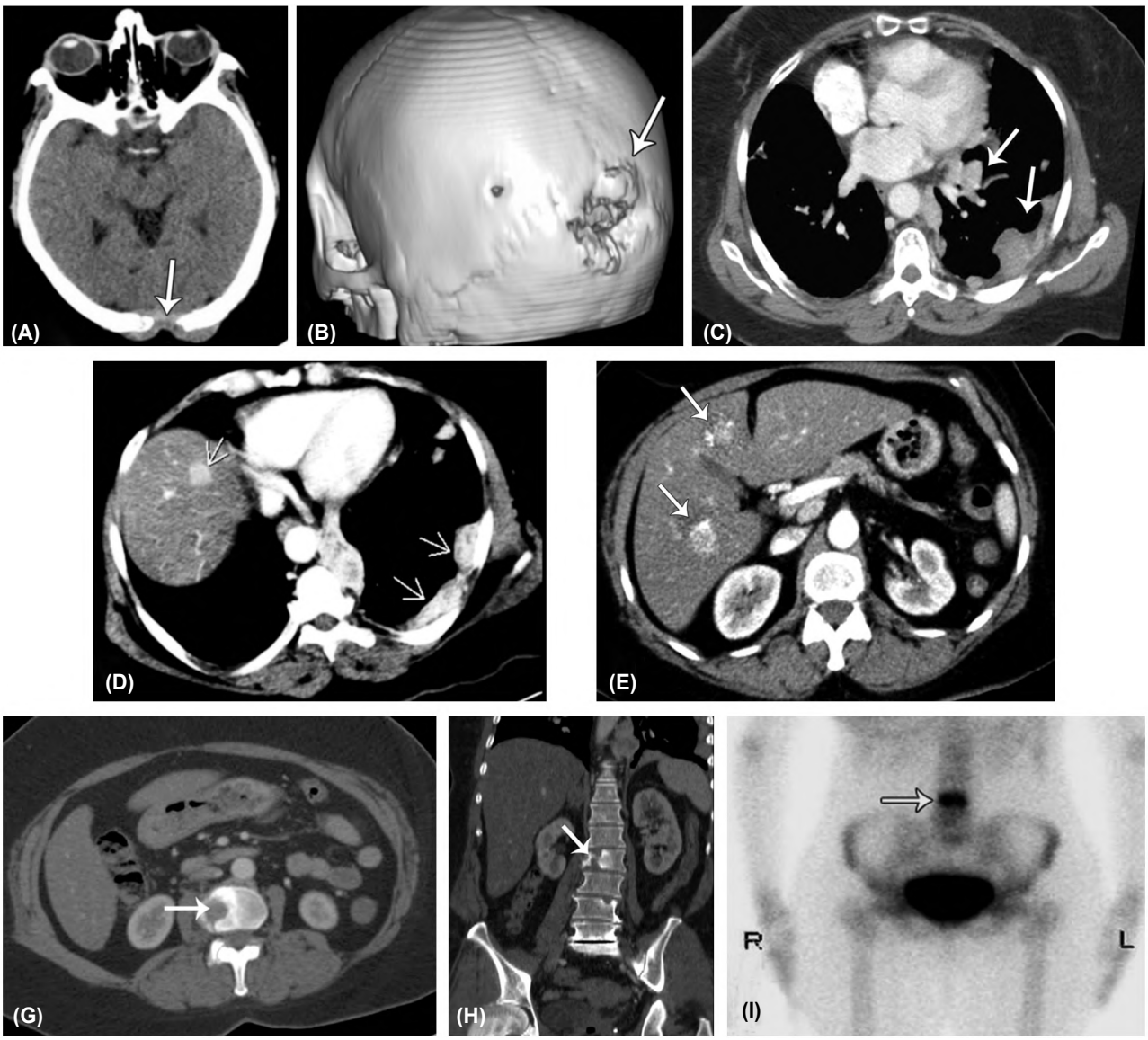


Fig. (2): (A,B): CT skull (A) axial and (B) volumetric VR -3D reformatting showing multiple osteolytic lesions of the skull bones associated with soft tissue component in the occipital and left parietal bones. (C,D,E): Axial post contrast CT chest and abdomen showing multiple variable sized pulmonary and plural soft tissue masses in both lung lobe (more in the left side) with few right liver lobe enhancing focal lesions. (G,H): Axial and coronal post contrast CT abdomen and pelvis showing osteolytic destructive lesions of L2 & L4 vertebrae. (I): Increased tracer uptake at L4 vertebra metastatic lesion.

Discussion

In the current work, the irregular shape and speculated margin were the most common morphological pattern among our patients with pathologically proven malignant lesions. Our results were concomitant with Inoue et al., who reported that irregular shape and speculated margins were the most accurate morphological evidence of malignancy.

In our work we compared sensitivity, specificity and accuracy of CECT, Mammography and sonography and we found that CECT was superior to both mammography and sonography in detection & characterization of the lesion and this result correlates with results of the study done by Wahab and Kareem **[15]**.

We found that oval shape is highly indicative of the benign nature of the mass, this is supported by the study done by Lin et al., that included 51 lesions had oval and rounded shape, with 48 of them were proven to be benign and only 3 of them were pathologically proven to be malignant with malignancy rate of 6%.

MDCT has a significant role in the staging and follow-up of breast cancer cases increasing its usefulness in the determination of the adequate therapy for the patient as well as determination of the prognosis of these cases Miranda et al., **[16]**.

Our results revealed that about (75%) of our patients show bone metastasis, (50%) show lung metastasis, (40%) show liver metastasis and about (5%) show special sites of metastasis as adrenal gland, ovaries, brain, chest wall and abdominal wall. This was agreed by Grant R Williams, et al., **[17]**. Who reported that bone, lung and liver were most common sites for metastatic deposits respectively.

Conclusions:

CT mammography combined with isotope scan proved high efficacy in detection of solitary primary and bilateral masses as well as metastatic lesions. It has the advantage of wide images scope to detect LNs as well as other skin and chest wall lesions. It can be used as highly accurate pre-biopsy marker.

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Conflict of Interest: Nil.

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دور التصوير بالنظائر المشعة والأشعة المقطعية فى تقييم الأورام السرطانية الملموسة للثدى مقارنة بالتصوير التقليدى

يتطلب تشخيص سرطان الثدى فحوصات محددة للكشف عن المرض وتجنب التدخل الجراحى فى الآفات الحميدة. علاوة على ذلك، يتطلب التخطيط العلاجى تقييماً دقيقاً قبل الجراحة لمدى الورم والكشف عن الآفات متعددة المراكز ومتعددة البؤر. هدفت هذه الدراسة إلى تقييم الدقة التشخيصية للأشعة المقطعية والنظرية فى الكشف عن سرطان الثدى والآفات الثانوية.

تضمنت هذه الدراسة ٣٨ مريضة تمت إحالتهن من مركز الأورام بجا معة المنصورة وعيادة الجراحة الخارجية بناءً على إكتشاف جسدى لكتل ثديية واضحة أو مريضات خضعن لعملية استئصال الثدى وأتين للمتابعة. خضع جميع المرضى للتاريخ السريرى والفحص، والموجات فوق الصوتية والتصوير الشعاعى للثدى، التصوير المقطعى بالصبغة، والمسح النظيرى وكذلك تقنية التصوير المقطعى / النظيرى المجمع.

وقد أظهرت نتائج دراستنا أن التصوير المقطعى بالصبغة مجتمعاً مع التصوير بالنظائر المشعة للثدى لهم حساسية ودقة عالية لتشخيص الكتلة الخبيثة. كشفت المقارنة بين التصوير المقطعى بالصبغة مقابل الطريقتين الإعتياديتين الأخريين أن الاختلاف كان ذا دلالة إحصائية عند مقارنته مع التصوير الشعاعى للثدى ولكنه لم يكن ذا دلالة إحصائية عند مقارنته بالتصوير بالموجات فوق الصوتية.

لذلك استنتجنا أن التصوير الشعاعى للثدى بالأشعة المقطعية بالصبغة مجتمعاً مع التصوير بالنظائر المشعة أثبت فعاليته العالية فى الكشف عن الكتل الفردية الأولية والثنائية وكذلك الكتل الثانوية. وأيضاً يتميز بميزة نطاق التصوير الواسع لاكتشاف الغدد الليمفاوية بالإضافة إلى آفات الجلد وجدار الصدر الأخرى. لذلك يمكن استخدامه كعلامة محددة دقيقة للغاية قبل الخزعة.