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# Multi Parametric Magnetic Resonance Imaging in Evaluation of Post Operative Breast

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**ABSTRACT**

**Background:** Multi-parametric magnetic resonance imaging (MPMRI) is essential for assessing regional axillary nodes, finding concealed breast cancer, and figuring out the cancer's spread. Investigating the diagnostic efficacy of multi-parametric breast MRI in the post-operative breast assessment was the aim of this study.

**Methods:** This prospective study included 40 female patients, aged 34 to 77 years, who had post-operative breast conditions. Each patient underwent evaluation using MPMRI.

**Results:** Sensitivity of the kinetic curves for detection of malignant masses was 91.67 % and specificity was 88.89%. Total choline (t-Cho) was significantly lower in benign lesions than in malignant lesions, with a cut - off value of 2, this gives a sensitivity of 83.33%, the specificity 77.78% and accuracy 80.95. The role of Multi parametric MRI in predicting the presence of a tumor was significant, with a high sensitivity (91.67%), specificity (92.86%), along with a significant (P <0.001). These metrics demonstrate MPMRI effectiveness in accurately identifying tumors, offering a reliable diagnostic tool compared to final biopsy results. Recurrence was significantly different between mammography group and MPMRI group (P=0.001).

**Conclusions:** MP MRI demonstrates significant diagnostic accuracy for identifying recurrent breast cancer after breast surgery.

***Keywords:*** *Multi Parametric Magnetic Resonance, Post Operative Breast, Total Choline, Diffusion Weighted Imaging*

## 1. INTRODUCTION

Breast cancer is the most common type of cancer, with an estimated 2.3 million new cases in 2020. diagnosed worldwide and poses a significant health burden. [1].

It is crucial to prevent local recurrence in women following mastectomy or breast-conserving therapy since it might lead to additional expenses, psychological strains, and a worse prognosis [2].

The accuracy of recurrence identification with mammography and ultrasonography (US) may be decreased by the combination of architectural distortion, increased density at the lumpectomy site, and post-treatment edema [3].

Multi-parametric magnetic resonance imaging (MPMRI) is frequently used to evaluate regional axillary nodes, find concealed breast cancer, and track the disease's spread. Its significance in breast cancer staging has been highlighted by numerous research. [4].

To assess the contralateral breast and determine the extent of the disease, MPMRI is usually performed following a diagnosis of palpable recurrence of malignant tissue [5].

A quantitative isotropic diffusion parameter is provided by diffusion-weighted imaging (DWI), a non-contrast method based on diffusion encoding in three orthogonal directions. It has become an important tool in assessing breast cancer, assisting in breast mass characterization, cancer staging, predicting chemotherapy response, and differentiating recurrence from post-treatment changes [6].

The sensitivity of MP breast MRI in detecting residual and recurrent tumors post-breast-conserving therapy (BCT) is notably high, and it has shown effectiveness in differentiating scar tissue from tumor recurrence [7].

Since contrast-enhanced breast MRI can identify multifocal, multicentric, and contralateral disease, it is considered the gold standard for local staging of breast cancer. [8]. It is more sensitive than ultrasonography and mammography. But because of its low sensitivity, there are more false positives, which may lead to needless workups or biopsies [9].

Diffusion-weighted imaging (DWI) combined with dynamic contrast-enhanced sequences can increase breast MRI's specificity and overall diagnostic precision [10].The European Society of Breast Imaging (EUSOBI) guidelines state that breast MRI can be used after surgery in three situations: first, for follow-up screening; second, to assess for local recurrence; and third, to detect residual disease in the early post-operative stage.[11].

This study aimed to determine the diagnostic accuracy of multi-parametric breast MRI in assessing the post-operative breast tissue.

## 2. PATIENTS AND METHODS

This prospective study was conducted on 40 female patients, ranging from 34 to 77 years old, with post-operative breast conditions. The research was carried out from November 2022 to November 2024, following approval from the Ethical Committee of Tanta University Hospitals, Tanta, Egypt. All patients gave informed written consent.

The exclusion criteria included patients with preoperative breast cancer, renal impairment, previous contrast media allergies (including idiosyncratic reactions to iodine or anaphylaxis), and contraindications to MRI. These excluded the following: metallic foreign bodies in the eyes, implantable neurostimulation devices, cochlear implants, cardiac implantable electronic devices (CIED) such as pacemakers, drug infusion pumps (e.g., for insulin, pain relief, or chemotherapy), metallic-component catheters (e.g., Swan-Ganz), metallic fragments such as bullets, shotgun pellets, or shrapnel, cerebral artery aneurysm clips, magnetic dental implants, tissue expanders, artificial limbs, hearing aids, and piercings. Patients were advised to remove any devices where possible.

All patients underwent comprehensive history taking, clinical evaluation, laboratory tests (such as kidney function tests), and radiological examinations, which involved ultrasound (US), DWI, dynamic contrast MRI, breast MR spectroscopy, and MP MRI. Under ultrasound guidance, pathological specimens were taken from the 40 patients utilizing true cut biopsy and fine needle aspiration biopsy.

### Multiparametric breast magnetic resonance imaging

Patients were told to take off all metallic objects and change into hospital gowns, including hairpins, coins, and earrings. The procedure was explained for reassurance, and the patients were informed about the examination's duration, the knocking sounds commonly heard during the scan, and the importance of staying still. The study was carried out using the General Electric (GE) Signa Explorer 1.5 Tesla and Siemens Altea 1.5 T closed magnets in the MRI unit.

Before putting the patient on the MRI table, an intravenous line was placed into the dorsum of the hand to guarantee that there would be little movement in between scans. The patient was placed in a prone posture on a platform that permitted the breasts hang freely in order to do the MRI breast assessment. The treatment was performed using a specialized breast coil. To avoid false positives from hormonal peaks, the MRI was planned for days 5–15 of the menstrual cycle or at least 4-6 weeks after the end of hormone replacement medication. The MRI was done at least nine months (ideally twelve months) after radiotherapy and six months following surgery. The transverse, sagittal, and coronal planes were used for the localization scans.

### Conventional MRI

FSE T1-weighted Imaging (T1WI): TR=8.6 ms, TE=4.7 ms, performed in the transverse plane. T2WI with Fat Suppression (TIRM): TR=5600 ms, TE=59 ms, in the transverse plane; slice thickness: 4 mm; spacing: 1 mm; image matrix: 320x314.STIR Imaging: TR=3000 ms, TE=30 ms, TI=150 ms, in both transverse and sagittal planes; slice thickness: 4 mm; spacing: 1 mm; image matrix: 320x314.

### Functional MRI

**DWI Imaging :** All patients with b-values of 0, 800, and 1000 s/mm² underwent DWI with the following parameters: phase encoding from anterior to posterior, TR = 2,267 ms, TE = 77 ms, slice thickness = 5 mm, 256x256 matrix, FOV = 450 mm, and voxel size = 4.7x4.6 mm. To avoid contrast effects, it was carried out prior to administering contrast and after verifying the lesion location on T2WI. Findings were gathered and ADC maps were created.

**Dynamic Contrast MRI Technique:** A dynamic contrast-enhanced MRI was carried out on the breast using a 2D fast gradient-recalled echo sequence with fat suppression for T1-weighted imaging. The acquisition parameters included a TR of 4.3 ms, TE of 1.3 ms, an 80° flip angle, slice thickness of 1 mm, and a 34x34 cm field of view. Scans were taken before and after administering 0.1 mg/kg of Gd-DTPA, at multiple intervals (1–8 minutes). Percent enhancement curves were constructed by defining regions of interest (ROIs) on lesions greater than 5 mm with mass-like characteristics, in accordance with the MR BI-RADS guidelines.

**Breast MR Spectroscopy Protocol:** MR spectroscopy was primarily performed using a single-voxel technique at a 1.5 T field strength. The usual acquisition parameters involved a TE of at least 135 ms to minimize the lipid signal and a TR between 1.5 and 3 seconds.

Other MR imaging capabilities consist of automated functions such as subtractions and maximum intensity projections (MIPs). Every patient had bilateral breast MRI scans during a single session. The report should describe the morphological findings and kinetic enhancement properties, including the type, size, location, distribution of the lesion, and any associated features. Ultimately, based on these findings, the lesion was categorized into one of the American College of Radiology (ACR) Breast Imaging-Reporting and Data System (BI-RADS) categories.

The MRI data was sent to the workstation (Advantage Window 4.7, GE Medical Systems), where post-processing of the images took place. All pulse sequence data were subsequently correlated with the histopathological findings.

**Statistical analysis**

For the statistical study, SPSS v26 (IBM Inc., Chicago, IL, USA) was utilized. The quantitative data, presented as means and standard deviations (SD), were compared between the two groups using an unpaired Student's t-test. The qualitative data was presented using frequencies and percentages (%) and analyzed using the Chi-square or Fisher's exact test, as appropriate. The ROC curve was used to assess diagnostic performance, including sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). If a two-tailed P-value was less than 0.05, it was considered statistically significant.

## 3. RESULTS

Age, complaints, site of breast mass, family history, type of operation, enhancement, histopathology, mammography, US, MRI BI-RADS and MPMRI were enumerated in **Table 1**

**Table 1: Age, complaints, site of breast mass, family history, type of operation, enhancement, histopathology, mammography, US, MRI BI-RADS and MPMRI of the studied patients**

| | | N=40 |
|---|---|---|
| **Age (years)** | | 58.10±12.69 |
| **30 ≤ 40y** | | 4(10.0%) |
| **40 ≤ 50y** | | 9(22.5%) |
| **50 ≤ 60y** | | 12(30.0%) |
| **60 ≤ 70y** | | 10(25.0%) |
| **70 - 80** | | 5(12.5%) |
| **Complaints** | **Breast lump** | 25(41.6%) |
| | **Diffuse breast enlargement** | 20(33.4%) |
| | **Breast pain** | 15(25.0%) |
| **Site of breast mass** | **Right breast** | 22(55.0%) |
| | **Left breast** | 18(45.0%) |
| **Family history** | | 25(62.5%) |
| **Type of operation** | **Lumpectomy** | 30(75.0%) |
| | **Quadraenctomy** | 5(12.5%) |
| | **Modified radical mastectomy** | 5(12.5%) |
| **Enhancement** | | 28(70.0%) |
| **Histopathology** | **Ductal carcinoma** | 38(95%) |

| | | |
|---|---|---|
| | **Lobular carcinoma** | 1(2.5%) |
| | **Mucinous carcinoma** | 1(2.5%) |
| **Mammography** | **Recurrence** | 2(5.0%) |
| | **Post operative scar** | 6(15.0%) |
| | **Seroma** | 4(10.0%) |
| | **Fat necrosis** | 3(7.5%) |
| | **Diffuse skin thickening and edema** | 6(15.0%) |
| **US** | **Recurrence** | 1(2.5%) |
| | **Post operative scar** | 4(10.0%) |
| | **Seroma** | 6(15.0%) |
| | **Fat necrosis** | 3(7.5%) |
| | **Diffuse skin thickening and edema** | 6(15.0%) |
| **BI-RADS** | **1** | 6(15.0%) |
| | **2** | 12(30.0%) |
| | **3** | 10(25.0%) |
| | **4** | 6(15.0%) |
| | **5** | 6(15.0%) |
| **MPMRI** | **Positive (Recurrent mass)** | 12(30.0%) |
| | **Negative (Benign)** | 28(70.0%) |
| | **Fat necrosis** | 6(15.0%) |
| | **Seroma** | 7(17.5%) |
| | **Diffuse skin thickening and edema** | 6(15.0%) |
| | **Post-operative scar tissue** | 9(22.5%) |

Data are presented as mean ± SD or frequency (%).US: ultrasound, MRI: magnetic resonance imaging, BI-RADS: breast imaging and reporting data system, MPMRI: multi-parametric magnetic resonance imaging.

Two cases were presented by non-mass lesion at the MRI, by histopathology and follow up, one of these lesions was proved to be malignant (recurrent) and one of them was benign (no malignant activity) and six patients were presented with no masses (only skin thickening and edema). Total choline (t-cho) at 3.2 ppm was assessed: t-cho more than 2 in 12 cases, two of them were proved histologically to be benign and the rest of them proved to be malignant (recurrent). **Table 2**

**Table 2: The distribution of the patients under study based on the MRI mass margins and the correlation between t-cho and the histopathology-based detection of recurrent malignant tumors**

| | | **Benign** | **Malignant** |
|---|---|---|---|
| **Margins of the lesions** | **Regular** | 10(31.25%) | 0 (0.0%) |
| | **Irregular** | 9(28.1%) | 2(6.25%) |
| | **Speculated** | 3 (9.3%) | 8 (25%) |
| **T cho** | **>2** | 2(22.2%) | 10(83.3%) |
| | **<2** | 7(77.8%) | 2(16.7%) |

Data is presented as frequency (%). T cho: total choline. MRI: magnetic resonance imaging.

Presence of intra-lesional fat SI (high T1 SI) was found in 6 patients (15%), all of them were benign (fat necrosis). Absent of intra-lesional high T1 SI (fat signal) was found in about 34 patients (85%); 22 patients of them showed benign MRI finding (benign lesions and post operative edema) and 12 patients displayed malignant MRI finding. low T2 signal intensity was found in 12 patients; 11 of them proved to be malignant and 1 of them was benign. Absent of low T2 SI were found in 28 patients (70 %) only one of them was histopathologically proved to be malignant (recurrent mass) and the other 27 patients showed no recurrent masses, so low T2 signal was an important factor in detection and suspecting malignant lesions in breast. **Table 3**

**Table 3: Relationships between low T2 signal, pattern of enhancement, presence of fat on T1WI, and recurring malignant tumor detection**

| | | Post operative edema only | Benign | Malignant |
|---|---|---|---|---|
| **Present of fat on T1** | **Absent** | 6(15.0%) | 16(40.0%) | 12(30.0%) |
| | **Present** | 0(0.0%) | 6(15.0%) | 0(0.0%) |
| **Low T2 signal** | **Absent** | 6(15.0%) | 21(52.5%) | 1(2.5%) |
| | **Present** | 0(0.0%) | 1(2.5%) | 11(27.5%) |
| **Pattern of enhancement** | **Heterogeneous enhancement** | 0(0.0%) | 3(7.5%) | 10(25.0%) |
| | **Smooth marginal enhancement** | 0(0.0%) | 9(22.5%) | 0(0.0%) |
| | **Homogenous enhancement** | 0(0.0%) | 4(10.0%) | 0(0.0%) |
| | **Non mass enhancement** | 0(0.0%) | 0(0.0%) | 2(5.0%) |
| | **No enhancement** | 6(15.0%) | 6(15.0%) | 0(0.0%) |

Data is presented as frequency (%).SI: signal intensity.

Type II (plateau) and III (wash out) curves were noted in 15 patients (Type II was seen in 8 patients and Type III in 7 patients). 4 of them was histologically proved to be benign postoperative changes (postoperative scar tissue), while the remaining 11 patients were recurrent malignant tumor. Sensitivity of the kinetic curves for detection of malignant masses was 91.67 % and specificity was 88.89%. t-cho was significantly lower in benign lesions than in malignant lesions, with a cut - off value of 2, this gives a sensitivity of 83.33%, specificity 77.78% and accuracy 80.95. **Table 4**

**Table 4: Relationship between kinetic curve type and histopathology-based recurring malignant tumor identification and T Cho at 3.2 ppm (t-Cho) in distinguishing between benign and malignant breast tumors**

<table>
<tr><th colspan="2"></th><th colspan="2">Benign</th><th colspan="2">Malignant</th><th>Test</th><th>P</th></tr>
<tr><td colspan="8">Kinetic curve</td></tr>
<tr><td colspan="2">Type I</td><td colspan="2">12(75.0%)</td><td colspan="2">1(8.4%)</td><td>--</td><td>--</td></tr>
<tr><td colspan="2">Type II</td><td colspan="2">3(18.7%)</td><td colspan="2">5(41.6%)</td><td>--</td><td>--</td></tr>
<tr><td colspan="2">Type III</td><td colspan="2">1(6.3%)</td><td colspan="2">6(50%)</td><td>--</td><td>--</td></tr>
<tr><td colspan="2">True positive</td><td colspan="2">11</td><td colspan="2">True negative</td><td>--</td><td>--</td></tr>
<tr><td colspan="2">False negative</td><td colspan="2">1</td><td colspan="2">False positive</td><td>--</td><td>--</td></tr>
<tr><td>Sens.</td><td colspan="2">Spec.</td><td>PPV</td><td>NPV</td><td>Accuracy</td><td>--</td><td>--</td></tr>
<tr><td>91.67%</td><td colspan="2">88.89%</td><td>84.62%</td><td>94.12%</td><td>90%</td><td>--</td><td>--</td></tr>
<tr><td colspan="2">T Cho</td><td colspan="2">1.26±0.4637</td><td colspan="2">4.155±1.036</td><td>t=7.232</td><td><0.001*</td></tr>
</table>

| Cut-off | Sens. | Spec. | PPV | NPV | Accuracy |
|---|---|---|---|---|---|
| ≤2 | 83.33% | 77.78% | 83.33 | 77.78 | 80.95% |

Data is presented as frequency (%). * Significant P value<0.05. T Cho: total choline, Sens: sensitivity, Spec.: specificity, PPV: positive predicted value, NPV: negative predicted value.

The ADC values were significantly lower in malignant (1.12±0.0× 10−3 mm2/s) than in benign lesions (1.488± 0.248 x 10−3 mm2/s), with a cut - off value of 1.1 x 10−3 mm2/s, this gives a sensitivity of 83.33%, specificity 85% and accuracy 84.38%. **Figure 1**

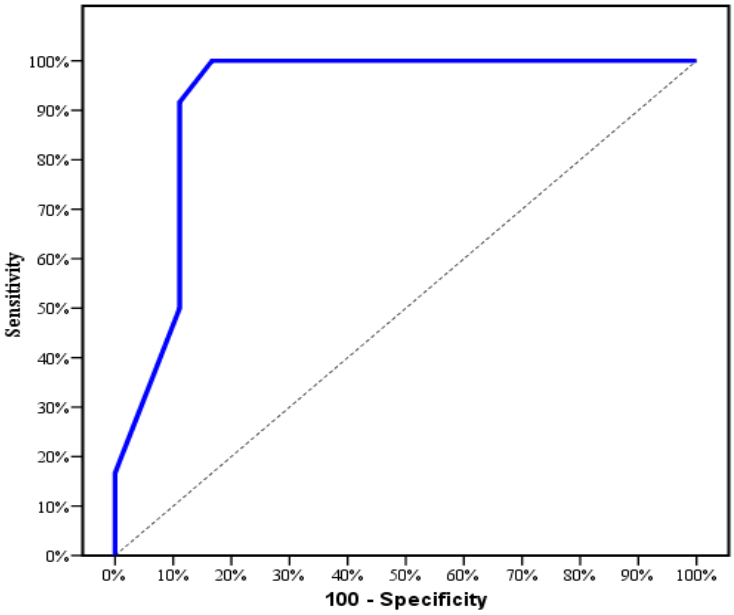



**Figure 1: ROC curve for evaluation of apparent diffusion coefficient values in detection of malignant lesions**

The role of Multi parametric MRI in predicting the presence of a tumor was significant, with a high sensitivity (91.67%), specificity (92.86%), PPV (84.62%), and NPV (96.30%), along with a statistically significant p-value (<0.001). These metrics demonstrate MPMRI effectiveness in accurately identifying tumors, offering a reliable diagnostic tool compared to final biopsy results. **Table 5**

**Table 5: Agreement (sensitivity, specificity and accuracy) for MRI finding**

| | Pathological findings | | Sensitivity | Specificity | PPV | NPV | Accuracy |
|---|---|---|---|---|---|---|---|
| | Negative (n = 28) | Positive (n = 12) | | | | | |
| **MRI finding** | | | | | | | |
| **Negative** | 26(92.9%) | 1(8.3%) | 91.67 | 92.86 | 84.62 | 96.30 | 92.50 |
| **Positive** | 2(7.1%) | 11(91.7%) | | | | | |
| **$\chi^2$ ($^{FE}$P)** | 23.220 | **<0.001*** | | | | | |

Data is presented as frequency (%). * Significant P value<0.05. $X^2$: Chi square test, FET: fisher exact test, PPV: positive predictive value, NPV: negative predictive value.

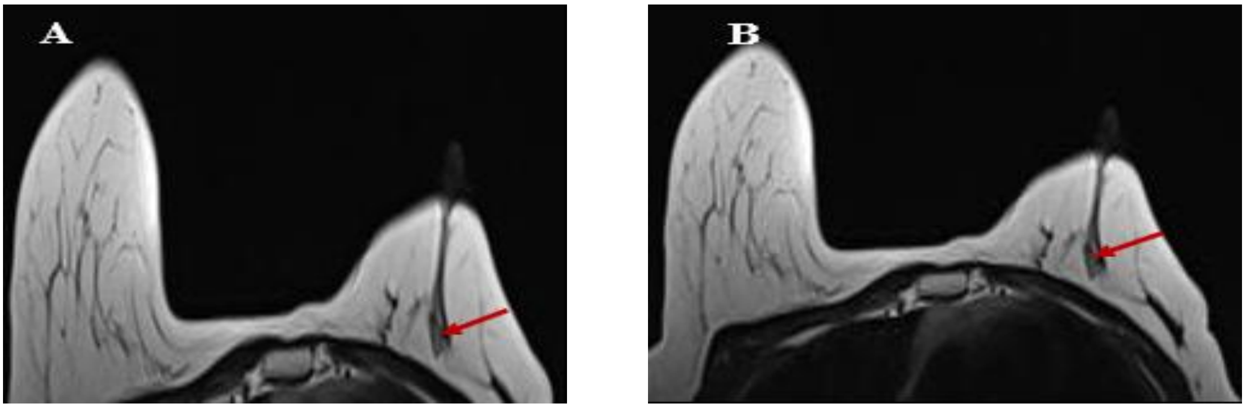
Recurrence was significantly different between mammography group and MPMRI group (P=0.001). Postoperative scar, seroma and fat necrosis were insignificantly different between mammography group and MPMRI group. **Table 6**

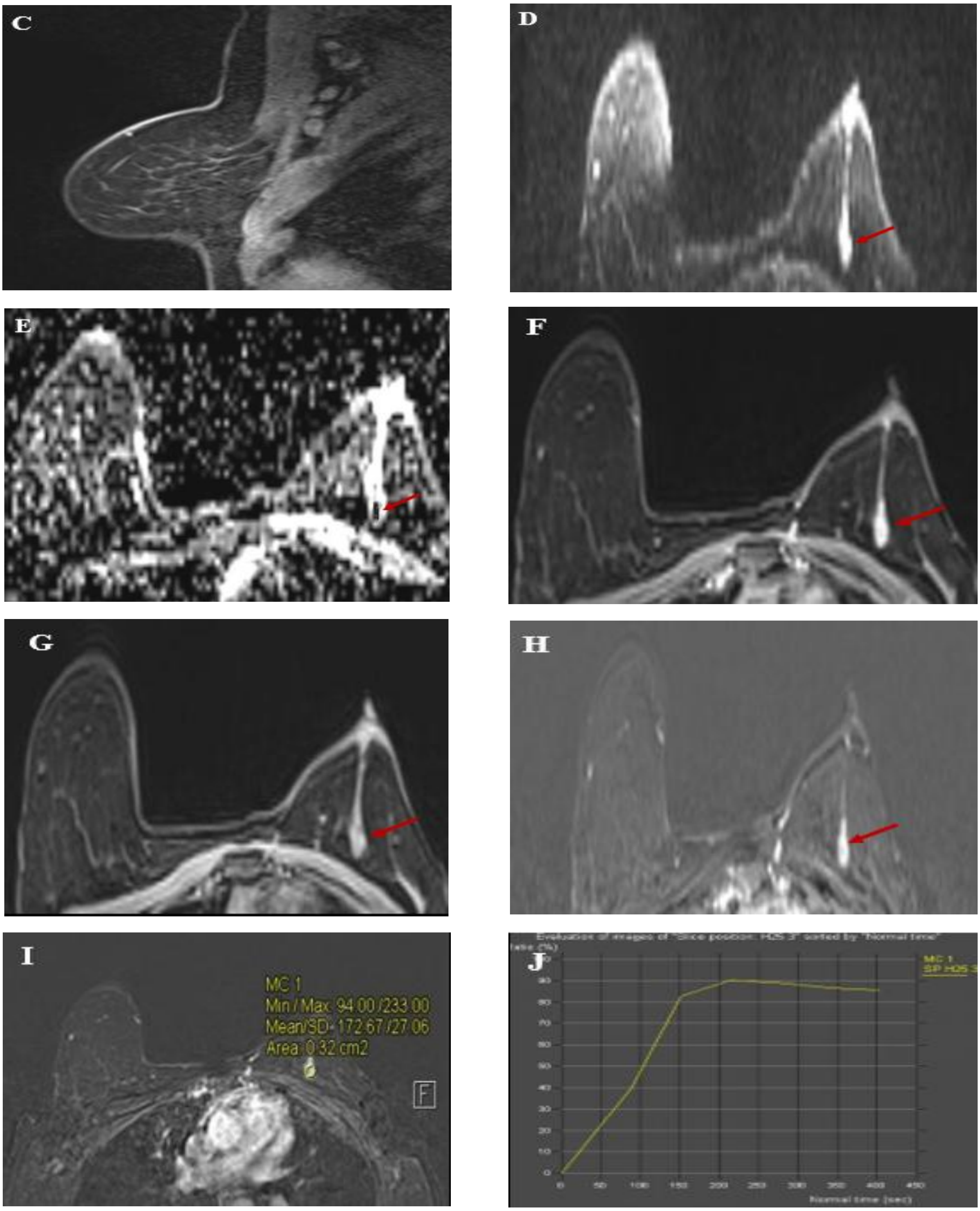
**Table 6: Comparison between MPMRI and mammography findings according to different parameters**

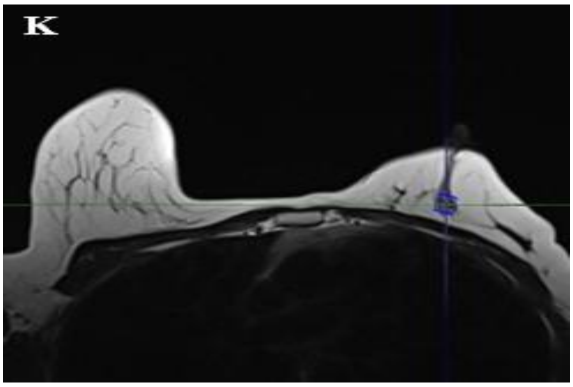
| | Mammography | MPMRI | $\chi^2$ | P |
|---|---|---|---|---|
| **Recurrence** | | | | |
| **Yes** | 2(5.0%) | 10(25.0%) | 10.667* | **0.001*** |
| **No** | 10(25.0%) | 2(5.0%) | | |
| **Postoperative scar** | | | | |
| **Yes** | 6(15.0%) | 7(17.5%) | 0.424 | $^{FE}$P=1.000 |
| **No** | 3(7.5%) | 2(5.0%) | | |
| **Seroma** | | | | |
| **Yes** | 4(10.0%) | 7(17.5%) | 4.0 | $^{FE}$P=0.172 |
| **No** | 3(7.5%) | 0(0.0%) | | |
| **Fat necrosis** | | | | |
| **Yes** | 3(7.5%) | 5(12.5%) | 1.667 | $^{FE}$P=0.534 |
| **No** | 3(7.5%) | 1(2.5%) | | |
| **Diffuse skin thickening and edema** | | | | |
| **Yes** | 6(15.0%) | 6(15.0%) | – | – |
| **No** | 0(0.0%) | 0(0.0%) | | |

Data is presented as frequency (%). * Significant P value<0.05. $X^2$: Chi square test, FET: fisher exact test, MPMRI: multi-parametric magnetic resonance imaging.

**Case 1:** A 37-year-old female patient underwent lumpectomy since 4 years, histologically proved to be lobular carcinoma in situ grade I, now complaining of breast mass at the operative bed, Ultrasound and Mammography revealed an ill-defined hypo echoic area of architecture distortion?? with ill-defined mass lesion seen within. So, diagnosis is: Left breast operative bed 12 o'clock mass with suspicious criteria as described likely recurrence. Multiple enlarged suspicious left axillary lymph nodes about 4 in number (level I and II lymph nodes) The overall criteria consistent with BIRADS IV. Histopathological study revealed: malignant mass (recurrent mass) at the site of the previous scar tissue. **Figure 2**




C
D
E
F
G
H
I
MC 1
Min / Max: 94.00 /233.00
Mean/SD: 172.67 /27.06
Area: 0.32 cm2
F
J
MC 1



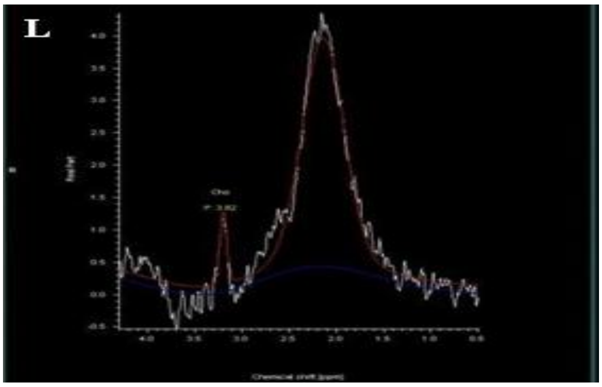




**Figure 2: (A) T1 weighted image, (B) T2 weighted image, (C) Sagittal T1 weighted image fat saturation, A well-defined irregular shaped soft tissue mass of altered SI is seen at left breast at its upper aspect at 12 o'clock the site of previous operative bed (red arrow) measured about 12x9 mm displayed hypointense signal intensity in T1 weighted image and T2 weighted image, multiple enlarged left axillary lymph nodes (about four in number) (asterisk) displayed hypointense signal intensity in T2 weighted image, largest at level one axillary lymph nodes measures 2.7x1.3 cm with thick cortex, (D) diffusion-weighted imaging, (E) apparent diffusion coefficient map, apparent diffusion coefficient value = 0.9 X 10-3. This small lesion at the scar showing small foci of restricted diffusion in diffusion, (G and H) dynamic post contrast images, (I) subtraction weighted images, (J) type II plateau kinetic curve, at post contrast study, the post operative scar tissue showed heterogeneous enhancement, Dynamic post contrast series reveal type II plateau curve denoting suspicious nature, (K and L) magnetic resonance spectrum (t cho at 3.2 ppm = 3.82 (high)**

## 4. DISCUSSION

In the past ten years, breast cancer survival rates have notably increased due to advancements in postoperative treatment. However, women who have received treatment for primary breast cancer still face the possibility of developing recurrent breast cancer [12].

In the current the study, most of the patients (30 cases, 70%) underwent lumpectomy (breast conservative surgery), then modified radical mastectomy (5 cases, 12.5 %), and quadranectomy (5 cases, 12.5%) which agreed with Al Tohamy et al. [13] reported lumpectomy was the most common, 26 patients (86.7%) underwent CBS (lumpectomy and quadranectomy) and 4 patients (13.3%) underwent modified radical mastectomy.

The histopathology of preoperative breast, the most common was ductal carcinoma (38 cases, 95%), 2.5% were invasive lobular carcinoma and 2.5% were mucinous carcinoma, this result is close to Teller et al. [14] where 75 patients (79%) were diagnosed with in situ or invasive ductal carcinoma. Infiltrating lobular carcinoma was observed in 17 patients (18%), and the remaining three patients had less common carcinomas, including metaplastic, tubular, and papillary types.

In the present study the mammographic findings revealed: recurrent masses detected in about 2 patients (5%), post operative scar and architecture distortion detected in 6 patients (15%), seroma was detected in about 4 patients (10%), fat necrosis was detected in about 3 cases (7.5%), diffuse skin thickening and edema was noted in about 6 patients (15%), so mammography was in sensitive in detection of post-operative current masses which disagree with Kim et al. [15] who found that mammography detected 66.1% (39 of 59) of recurrent lesions, excluding those on the chest wall (n = 21) or in the ipsilateral axillary lymph nodes. Of the identified lesions, 38 (67.9%) presented visible signs of malignancy on craniocaudal and/or mediolateral oblique digital mammograms.

According to margins of the lesions at conventional MRI, regular outlines was found in the most cases with benign lesions (31.25 %) and irregular \speculated outlines have been found in most cases with malignant lesions, irregular outlines in 2/12 malignant cases and speculated outlines in 8/12 malignant cases which agreed with Kul et al. [16] found that 80% of the malignant masses had irregular/ speculated, and 81% of benign masses had round or oval-lobulated shape (regular outlines).

In our study, low T2 signals were found in 12 patients; 11of them were proved to be malignant and 1 of them was benign. Low T2 SI absent in 28 patients (70 %); only one of them was histopathologically proved to be malignant (recurrent mass) while rest of them showed no recurrent masses, so lesions that are low at T2 are suspicious and those that are high T2most of them were benign lesions. These results agreed with Baltzer et al. [17] in which low SI T2WI was found in 15 cases (75%) malignant cases, 5 cases (25%) benign cases, high T2 WI was found in 7 benign cases (77%) and 2 malignant cases (22.2%).

According to pattern of enhancement in the current study; homogenous enhancement and smooth marginal enhancement had been found in most of benign cases (homogenous enhancement was found in 10%, smooth marginal enhancement was found in 22.5% of benign cases)and heterogonous enhancement was found in most of malignant cases (10 malignant cases (25%)

and 3 benign cases 7.5%), which agreed with Hossam et al. [18] in which heterogeneous enhancement was present in 4 malignant cases (80.0%) and 2 benign lesions (15.4%), marginal enhancement is present in 4 benign cases (30.8%), non-mass like enhancement was present in one benign case (7.7%) and one malignant case (20%), so marginal enhancement was found in most benign cases and heterogeneous enhancement was associated in most malignant cases.

The current study found that Type III curve was the most common in pathologically proven malignant cases, occurring in 6 out of 12 cases (50%). Type II was observed in 5 malignant cases (41.6%). For benign cases, the most common curve type was Type I, seen in 75% of pathologically confirmed benign cases. The results are comparable to those reported by Yang et al.[19] who found that Type 1 curves appeared in 83±5% of benign lesions and 17±5% of malignant lesions. For Type 2 lesions, benign and malignant lesions were found in 32±6% and 68±6% of cases, respectively. For Type 3 lesions, the percentages were 18±2% for benign lesions and 82±2% for malignant lesions. So, the sensitivity of the kinetic curves for detection of malignant masses was 91.67 % and specificity was 88.89% which agree with Amin et al. [20] reported that kinetic curves produced sensitivity, specificity and accuracy of 95.4%, 86.95% and 91.1 %, respectively.

The study revealed that malignant lesions had a lower mean ADC value ($1.04 \pm 0.09 \times 10^{-3}$ mm²/s) compared to benign lesions ($1.388 \pm 0.118 \times 10^{-3}$ mm²/s), with a cut-off value of $1.1 \times 10^{-3}$ mm²/s. ROC curve analysis showed a sensitivity of 83.33%, specificity of 15%, and accuracy of 84.38%. These findings are in line with Akin et al. [21] who identified a similar ADC threshold of $1.11 \times 10^{-3}$ mm²/s, but with significantly higher sensitivity (94.23%), specificity (94.29%), and diagnostic accuracy (98%).

Numerous studies, including those by EI Khouli et al., have reported that ADC values are significantly lower in malignant lesions compared to benign lesions [22].

In this study, t Cho levels were notably lower in benign lesions than in malignant ones, with a cut-off value of 2, yielding 83.33% sensitivity, 77.78% specificity, and 80.95% accuracy. These findings are in line with those of Hassan et al. [23] who identified a significant difference in the Cho peak at 3.2 ppm between benign and malignant lesions. A high choline peak (>2) was present in 27 (84%) malignant lesions, while a value below 2 was observed in 5 (16%) malignant cases. The cut-off for benign lesions was also set at 2, with 34 (79%) cases showing values below this threshold.

The current study found that multiparametric MRI detected 30% of recurrent malignant tumors, 15% of postoperative fat necrosis, 17.5% of postoperative seroma, 22.5% of postoperative scar tissue, and 15% of diffuse skin thickening and edema. Histopathology confirmed these results. These findings are consistent with the study by EL-Adalany. [24] who reported that According to the study, six patients (12%) had postoperative scar tissue, ten patients (20%) developed postoperative seroma, ten patients (20%) had diffuse skin thickening and edema, seven patients (14%) had postoperative fat necrosis, and twelve patients (24%) had recurrent malignant tumors. Five patients, or 10% of the total, were judged to be normal.

The present study reported that multi para metric MRI is more sensitive in detection of recurrent masses than mammography. Mammography detected 2 of 12 cases (16.7%) while Mpm MRI detected 10 of 12 cases (83.3%). The findings align with those of Raikhlin et al. [25] who found that 12 out of 13 cancers (92.3%) were detected by MRI, while mammography identified four (30.8%). Notably, in nine of these patients, the cancer was diagnosed exclusively by MRI.

The use of multiparametric MRI in predicting tumor presence is highly significant, with MRI showing excellent sensitivity in detecting breast cancer, particularly in distinguishing scar tissue from recurrent tumors. In this study, sensitivity (91.67%), specificity (92.86%), PPV (84.62%), and NPV (96.30%) were achieved. These results are consistent with Al Tohamy et al., 2023 [184], who reported no false negatives and only two false-positive lesions. Their results showed 100% sensitivity, 88.9% specificity, 85.7% PPV, 100% NPV, and 93.3% accuracy, agreeing with studies by Pinker et al. and others. [26].

Some limitations of the study included a small sample size and short follow-up periods for the patients. Additionally, distinguishing normal enhancing structures from tumors posed a challenge, and the study did not correlate findings with other diagnostic modalities.

## 5. CONCLUSIONS

The integrated interpretation strategy, which combines enhancement kinetics data with morphological feature analysis, proves to be more effective than using either method independently. The combination of multiple MRI parameters, including DCE-MRI, DWI, and MRSI, is highly valuable in distinguishing local recurrence from other post-operative changes in patients with recurrent breast cancer. Multiparametric MRI offers high diagnostic accuracy for detecting post-operative recurrent breast cancer

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