Diagnostic Performance Of Diffusion Tensor Imaging Parameters In Breast Tumors Comparing To Diffusion Weighted Imaging And Dynamic Mri Imaging

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KEYWORDS

ADC,
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ABSTRACT

Background: Diffusion tensor imaging (DTI) is a new technique that uses additional gradients to detect the degree of diffusion in multiple directions (at least six). It measures the full diffusion tensor describing the degree of anisotropic water diffusion in the tissue, quantified with the parameters mean diffusivity (MD) and fractional anisotropy (FA). Similar to the ADC, MD reflects the average anisotropy, and FA describes the degree of anisotropy.

Aim: The current study aimed to explore the value of diffusion tensor imaging (DTI) parameters to differentiate between benign and malignant breast lesions compared to diffusion weighted MRI and Dynamic Contrast Enhanced imaging.

Patients and methods: The study involved 64 patients, who presented with a total of 68 breast lesions, including multicentric and multifocal disease. This prospective study was designed to assess whether DTI could provide superior diagnostic accuracy in distinguishing between benign and malignant lesions.

Results: Contrast MRI gives a sensitivity of (94.83%) specificity (80.0%) and accuracy (92.65%). ADC values were significantly lower in malignant (1.054±0.284× 10−3 mm2/s) than in benign lesions (1.388±0.228× 10−3 mm2/s), with a cut-of value of 1.21× 10−3 mm2/s; this gives a sensitivity of (87.93%) specificity (80.0%) and accuracy (86.76%). FA values significantly higher in malignant (0.29±0.453× 10−3 mm2 /s) than benign lesions (0.129±0.032× 10−3 mm2/s) with a cut-of value of 0.15 × 10−3 mm^2 /s. Mean FA may significantly predict malignant pathology sensitivity (98.28%), specificity (90.0%) and accuracy (97.06%). Concerning the results of MD measurements, the current work showed lower values in malignant tumors (0.29±0.453× 10−3 mm2 /s) than benign lesions (1.75±0.670× 10−3 mm2/s) with a cut-of value of 1.5 × 10−3 mm2 /s. This gives sensitivity (96.55%), specificity (90.0%) and accuracy (95.59%). DTI achieved a higher specificity than DCE-MRI and Diffusion, the combined techniques increased the sensitivity to 100% and specificity to 94 %.

Conclusion: DTI can be used as an adjuvant sequence in diagnostic CE-MRI breast. While the DWI is still the most established diffusion parameter for differentiation between benign and malignant breast lesions, DTI may be helpful in further characterization of tumor microstructure which definitely needs further investigations. Values of FA was significantly higher in malignant than benign lesions, values of ADC and MD were significantly lower in malignant than benign breast lesions, breast DTI is a noninvasive method that demonstrated a high potential utility for cancer detection and serving as a stand alone techniques in conjunction with DCE-MRI, the discriminating values of FA were high.

Introduction

In breast radiology, mammography and ultrasound are the fundamental imaging modalities. These instruments' comparatively limited sensitivity led to a need for novel imaging modalities (1).

Due to its poor specificity (72%), dynamic contrast enhanced MRI is still difficult to distinguish between benign and malignant breast lesions, despite its excellent contrast resolution providing great sensitivity (90%) in the diagnosis of breast cancer. Diffusion weighted imaging (DWI), which uses a novel contrast technique, offers a high sensitivity in detecting hanges in the microscopic cellular environment without the requirement for contrast injection (2).

Moreover, DWI provides quantitative analysis via the use of apparent diffusion coefficients (ADC). By capturing the cellularity and integrity of cell membranes in the tissue, this measures Brownian motion. The diagnostic accuracy of dynamic contrast enhanced MRI was increased with the use of DWI as a supplementary approach (3).

Diffusion tensor imaging (DTI) is a novel method that detects the degree of diffusion in at least six

directions by using extra gradients. It quantifies the degree of anisotropic water diffusion in the tissue using the parameters mean diffusivity (MD) and fractional anisotropy (FA), which together make up the entire diffusion tensor. Like the ADC, FA indicates the degree of anisotropy, whereas MD represents the average anisotropy (4).

Several investigations have been conducted to evaluate DWI's diagnostic efficacy in distinguishing between benign and malignant breast lesions. ADCs in malignant tumors were shown to be much smaller than those in benign lesions, and the diagnostic accuracy of conventional MRI was improved by the addition of DWI (5).

The effectiveness of DTI parameters, MD and FA, in both normal breast tissue and lesions has been evaluated in a few more recent DTI investigations. In contrast to benign lesions, malignant tumors were shown to have much lower MDs, whereas FA produced findings that were contentious. Directionality and the amount of water molecule diffusion may be determined using diffusion tensor imaging (DTI), a more sophisticated kind of diffusion weighted imaging (DWI) (6).

The degree of diffusion anisotropy and the corresponding principal diffusion direction in each voxel may be determined more easily using DTI than with DWI (7).

Diffusion Tensor Imaging (DTI) has the potential to enhance traditional diffusion methods for more accurate assessment of breast lesions. The traditional DWI method implies that water protons diffuse isotropically freely and unhindered. The parameters of water diffusion vary with direction, and the free displacement of water molecules is really restricted by the many compartments and barriers found in biological tissues. DTI can define diffusion in three-dimensional (3D) regions and determine the extent of anisotropic water diffusion in the tissue since it encodes diffusion in six or more directions (8).

Aim

The aim of this study was to explore the value of diffusion tensor imaging (DTI) parameters to differentiate between benign and malignant breast lesions compared to diffusion weighted MRI and Dynamic Contrast Enhanced imaging.

Patients and methods

This study was conducted in the Radiology Department of the national cancer institution during the period from 2018 till 2024. This prospective observational cohort research was performed on 64 females aged 26–75 years old featured with breast complaints and/or abnormal sono-mammographic findings.

Patients with a history of known breast lesions on mammography, US or conventional MRI and patients with history of surgical excision of breast lesion on follow up were included in the study. While patients known to have contraindications for MRI e.g. an implanted magnetic device, pacemakers and severe renal insufficiency with glomerular filtration rate 2.0 mg/dl as regards contrast injection, patients with contraindication to intravenous contrast material injection (allergic patients or those known to have history of complication from contrast media such as anaphylactic reaction) or patients with a bad general condition were excluded from the study.

All patient were subjective to history taking included: Full personal and clinical history including Onset, course and duration of the complaint. History previous lump resection and/or biopsy. Presence of family history. Instructions and preparation of the patients: - 1. The patients were checked for contraindications, ferromagnetic materials within the patients as cardiac pacemaker, prosthetic heart valve, internal drug infusion pumps, neuro-stimulators and bone-growth stimulators. 2. All metallic objects such as clothes containing metal, dentures, pins, earrings and necklaces were removed before the examination. 3. The examination was explained briefly to the patients, they were also informed about the knocking sounds which are usually heard during the examination and told about the length of examination and the value of remaining motionless.

Technique Conventional and dynamic MRI sequences were done for all patients on a 1.5 Tesla MRI (Philips Achieva XR) in the standard prone position, using a 4-channel dedicated breast coil.

- Axial T1-weighted imaging (TE 10 ms, TR 413 ms thickness of section 3 mm, 340_512 matrix, field of view [FOV] 457 mm). T2WI axial (TE 120 ms, TR 4,374 ms).
- T2WI axial with suppression of fat (TE 70 ms, TR 3,997 ms, 3-mm section thickness). STIR (TE=30 ms, TR=3000 ms, TI=150 ms) in the transverse and sagittal plane; slice thickness: 4 mm; spacing: 1 mm; image matrix: 320×314.
- DTI and DWI were performed complementary to dynamic contrast MRI.
- Apparent diffusion coefficient (ADC) of DWI, mean diffusivity (MD) and fractional anisotropy

(FA) values of DTI were measured for lesions and contralateral breast parenchyma in each patient. Contrast: Injection of 0.1 mmol per kg of body weight (Gadolinium dimeglumine) (Gd-DTPA) (Magnavist, Schering AG Berlin, Germany), at a rate of 2 mL/s, using an automatic injector, followed by a 20-mL saline flush was done for all patients. Imaging analysis and interpretation: Quantitative analyses were done using a dedicated workstation (Philips Medical Systems National Cancer Institute Cairo University). ADC, MD and FA, the localization of ROI's were determined in consensus. The quantitative analysis of DWI and DTI, ADC and FA maps were created automatically by the imaging console. Three ADC values for DWI were measured separately from ADC maps with values of 0, 1000 (ADC1); 0, 1500 (ADC2), and 50, 850 (ADC3) s/mm2. MD and FA values from DTI will be measured on the ADC map with values of 0 and 1000 s/mm2.

- The measurements were done by placing the ROI's on the lesion and the normal parenchyma on the contralateral breast. The ROI was placed on the lesion including the largest possible volume without including necrotic, hemorrhagic and cystic components. The subtraction images from the dynamic contrast series were used as a guide to avoid areas of pathologic enhancement. The measurements were repeated twice and the average recorded as the final result.

Statistical analysis

Data was analyzed using IBM SPSS advanced statistics (Statistical Package for Social Sciences), version 27 (SPSS Inc., Chicago, IL). Qualitative data was described as numbers and percentages. Numerical data was described as mean and standard deviation or median, interquartile range or range. Testing for normality will be done using Kolmogorov-Smirnov test and Shapiro-Wilk Test. Comparisons between the 2 groups for normally distributed numeric variables was done using the Student t test while for non normally distributed numeric variables done by Mann-Whitney test. sensitivity, specificity, Positive Value of Prediction and Negative Value of Prediction were calculated.

Results

This study included 64 female patients with 68 breast lesions (bilateral lesions in some patients) . Frome table 9: 14 patients had a positive family history. The age of our patients varied from 26 to 75 years, with the mean age was 47.4±10.7. 63 patients (98.4%) were represented by mass lesions.

Table 1: Illustrate the age, family history and clinical presentation in our 64 patients:

		No.	Percent
Age(yrs.)	Mean ±SD	47.4±10.7	
	Range	26-75	
Family history	Negative	50	78.12
	Positive	14	21.88
Clinical	Mass	63	98.44
	Pain	1	1.56

Table 2 shows MRI appearance of breast lesions. Most of the mass with heterogeneous enhancement patterns were in malignant lesions (37 lesions, 77.08%) that were statistically significant than benign lesions (11 lesions, 16.18%).

Table 2: contrast MRI and pathologic findings of studied patients

MRI		Count	%
Lesion Number (n=68)	Diffuse	1	1.47
	Multicentric	25	36.76
	Multifocal	21	30.88
	Single	21	30.88
Mass Presence	No	20	29.41
	Yes	48	70.59
Mass Shape (n=48)	Irregular	36	75.00
	Oval	5	10.42
	Rounded	7	14.58
Mass Margins (n=48)	Circumscribed	5	10.42
	Irregular	1	2.08
	Lobulated	15	31.25
	Spiculated	27	56.25
Mass Enhancement (n=48)	Heterogeneous	37	77.08
	Homogeneous	5	10.42
	Ring	6	12.50
Non-Mass Enhancement (n=20)	Clumped	13	65.00
	Heterogeneous	7	35.00
Non-Mass enhancement Distribution (n=20)	Diffuse	14	70.00
	Linear	1	5.00
	Regional	1	5.00
	Segmental	4	20.00
Nodes (n=68)	No	29	42.65
	Yes	39	57.35
Node Status (n=39)	Malignant	36	92.30
	Benign	3	7.70
Axillary Node (n=68)	Benign	3	4.41
	No	29	42.65
	Suspicious	36	52.94
Associated Findings (n=68)	No	51	75.00
	Yes	17	25.00
	Nipple Infiltration	1	5.88

Significant Associated Findings (n=17)	Pectoral Muscle Infiltration	4	23.53
	Skin And Nipple Infiltration	10	58.82
	Skin Infiltration	2	11.76
Dynamic curve type (n=68)	No	2	2.94
	Type I	31	45.59
	Type II	26	38.24
	Type III	9	13.24
Conclusion (n=68)	Benign	11	16.18
	Malignant	57	83.82
Pathology type	Invasive Ductal Carcinoma	41	60.29
	DCIS	8	11.76
	Invasive Lobular	6	8.82
	Fibrocystic Disease	4	5.88
	Mixed	3	4.41
	Fibroadenoma	2	2.94
	Hamartoma	2	2.94
	Inflammatory Duct-ectasia	2	2.94
Pathology Grade	I	3	4.41
	II	42	61.76
	III	23	33.82
Diagnosis Pathology	Malignant	58	85.29
	Benign	10	14.71
Associated DCIS	No	30	44.12
	Yes	38	55.88

From table 3, correlation with histopathological results demonstrated that dynamic contrast enhancement MRI produced sensitivity, specificity and accuracy of 94.83 %, 80.0% and 92.65%, respectively. ADC values were significantly lower in malignant (1.054±0.284× 10−3 mm2/s) than in benign lesions (1.388±0.228× 10−3 mm2/s), with a cut-of value of 1.21× 10−3 mm2/s; this gives a sensitivity of 87.93%, specificity 80.0% and accuracy 86.76%. FA values were significantly higher in malignant tumors (0.29±0.453× 10−3 mm2 /s) than benign lesions (0.129±0.032× 10−3 mm2/s) with a cut-of value of 0.15 × 10−3 mm2, gives sensitivity, specificity, and accuracy of 98.28%,90.0%, and 97.06%, respectively. MD values were significantly lower malignant tumors (0.29±0.453× 10−3 mm2 /s) than benign lesions (1.75±0.670× 10−3 mm2/s) with a cut-of value of 1.5 × 10−3 mm2 /s,. Mean MD gives sensitivity, specificity, and accuracy of 96.55%,90.0%, and 95.59%, respectively.

Table 3: Sensitivity, specificity and Accuracy of the study imaging in correlation with pathology :

	MRI	ADC	FA	MD
Sensitivity	94.83%	87.93%	98.28%	96.55%
Specificity	80.0%	80.0%	90.0 %	90.0%
Positive Predictive Value (Precision)	96.49%	96.23%	98.28%	98.25%
Negative Predictive Value	72.73%	53.33%	90.0%	81.82%
False Positive Rate	20.0%	20.0%	10.0%	10.0%
False Discovery Rate	3.51%	3.77%	1.72%	1.75%
False Negative Rate	5.17%	12.07%	1.72%	3.45%
Accuracy	92.65%	86.76%	97.06%	95.59%

Collectively, analyzing data of the present study, among DTI parameters FA showed the highest diagnostic accuracy with sensitivity (98.28%) and specificity (90.00%). Following, MD with specificity and sensitivity of (96.55%) and (90.00%), respectively, DCE sensitivity and specificity were (94.83%) and (80.00%), respectively, the MRI diffusion ADC value in our study show sensitivity and specificity (87.93%) and (80.00%), respectively.

Table 4: DTI and MRI diffusion conclusions of studied Cases

		Count	%
DTI Conclusion	Benign	10	14.71
	Malignant	58	85.29
		Count	%
MRI Diffusion conclusion	Benign	15	22.06
	Malignant	53	77.94

Discussion

Improving patient outcomes in the battle against breast cancer, which is still one of the most common tumors worldwide, depends on early and accurate identification of breast abnormalities (9). The introduction of new imaging technology aims to enhance diagnostic capabilities and distinguish between benign and malignant breast cancers.

According to Baltzer et al. (10), these developments include imaging techniques like diffusion tensor imaging (DTI) and dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI). Our study's objective was to compare the efficacy of diffusion tensor imaging (DTI) parameters vs diffusion-weighted magnetic resonance imaging (DW-MRI) and dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) in the identification of breast cancer. 68 breast lesions, including multifocal and multicentric disease, were seen in all 64 research individuals. In comparison to conventional diagnostic techniques, this prospective research aimed to determine if DTI could more reliably differentiate between benign and malignant tumors. We examined the mass morphology, margins, and lesion-wide enhancement patterns as imaging features. Additionally evaluated were the diagnostic efficacy, specificity, and sensitivity of DTI and DCE-MRI. Using additional gradients, DTI is a novel method that measures diffusion in at least six directions.

According to Amin et al. (11), this enables the measurement of diffusion in a three-dimensional (3D) anisotropic space using the parameters FA and MD. According to the current research, malignant tumors had much lower diffusion tensor imaging (DTI) parameters (MD) than benign lesions.

This is in line with what was documented in the works of Onaygil et al. (12), Jiang et al. (13), Cakir et al. (1), and Partridge et al. (14).

Jiang et al. (13) reported that tissue cellularity in breast lesions was significantly connected with MD and FA, and that the cellularity of breast cancer was greater than that of benign lesions. The increasing cellularity of malignant tissues may be the cause of the decline in diffusion coefficients, according to Beppu et al. (15). This would restrict the diffusion activity of water molecules in the extracellular compartment. Furthermore, a decrease in diffusion coefficients in all directions may result from cancer cells blocking ducts and lobules. The evaluation of MD might enable the estimation of the anisotropic water diffusion coefficient in a tissue and the three-dimensional description of diffusion (16).

The present study's MD measurement findings, with a cut-off value of 1.5 × 10−3 mm2 /s, revealed lower values in malignant tumors (0.29±0.453× 10−3 mm2 /s) than in benign lesions (1.75±0.670× 10−3 mm2/s). With an area under the curve (AUC) of 0.846, sensitivity of 96.55%, and specificity of 90.0%, mean MD may be a substantial predictor of malignant pathology.

The findings of Onaygil et al. (12) are somewhat similar to this. They showed that the mean values for benign and malignant lesions were 1.916±0.30× 10−3 mm2/s and 1.276±0.19× 10−3 mm2/s, respectively, with cutoff points of 1.59, sensitivity (97.8%), and specificity (87.2%). According to Onaygil et al. (12), the mean MD value in benign lesions was 1.686±0.27, whereas the mean MD value in malignant lesions was 1.036±0.19× 10−3 mm2/s. For a cut-off value of 1.24× 10−3 mm2/s, the sensitivity and specificity were 95.6% and 93.6%, respectively.

Regarding the FA measurement results, the current study found that malignant tumors had higher values (0.29±0.453× 10−3 mm2/s) than benign lesions (0.129±0.032× 10−3 mm2/s), with a cut-off value of 0.15 × 10−3 mm2/s. This results in sensitivity, specificity, and accuracy of 98.28%, 90%, and 97.06%, respectively. This is somewhat in line with Amin et al. (11) findings, which showed that FA levels were significantly higher in malignant (0.202±0.065) compared to benign lesions (0.129±0.033) with a cut-off value of 0.15, yielding 95.83%, 96.15%, and 95.6% sensitivity, specificity, and accuracy, respectively. When the current study's findings are analyzed and ADC and DTI parameters are assessed as indicators of benign and malignant lesions, ADC provides a sensitivity of 87.93%, specificity of 80%, and accuracy of 86.76%. It is evident that DTI parameters FA and MD have better sensitivity (98.28%), specificity (90%), and 96.55%.

The findings of Tsougos et al. (7), who assessed the ADC and DTI parameters as markers of benign and malignant tissue discrimination, contrast with this. The sensitivity and specificity of the ADC are 85% and 84.4%, respectively, while the FA's were 65.8% and 67.4%. With sensitivity (98.28%) and specificity (90.00%), FA had the greatest diagnostic accuracy among the variables under study. MRI diffusion ADC value in our research shows sensitivity and specificity (87.93%) and (80.00%), respectively, whereas DCE sensitivity and specificity were 94.83 percent and 80.00 percent, respectively. MD had specificity and sensitivity of 96.55% and 90.00 percent, respectively.

According to Tsougos et al. (7), who studied the function of DTI in distinguishing breast lesions, MD is the most discriminative DTI measure for breast lesion identification (sensitivity of 82.5% and specificity of 81.4%).

According to Wang et al. (17), ADC has the highest discriminative values, while MD performs remarkably comparable to ADC in terms of sensitivity and specificity. One possible explanation for the disparity between our findings and those of the earlier research is the variability around b-values. The number of gradient directions and the chosen b-values differ across investigations.

This might potentially impact the DTI parameter estimate process. We used b-values of 50, 850 (ADC3), s/mm2, 40 directions, and 0, 1000 (ADC1) and 0, 1500 (ADC2) in our investigation. Comparatively speaking to earlier research, Cakir et al. (1) used b-values of 0, 1000, and 16 directions, Onaygilet al. (12) used b-values of 0, 700, and 30 directions, and Luo et al., 2019 utilized b-values of 0, 100, 800, and six directions.

Comparing the diagnostic efficacy of DTI and DCE in 64 patients analyzed using both methods, DTI outperformed DCE-MRI in terms of specificity. The sensitivity reached 100% and the specificity DCE reached 94% as a result of the combined assessment. The findings of a research conducted by Onaygilet al. (12) indicate that the addition of DTI parameters to DCE-MRI raises the sensitivity to 100% and the specificity from 83.0 to 93.6%.

According to Wang et al. (17), the use of DTI in DCE-MRI may enhance diagnostic performance, as the specificity of DCE-MRI rose from 84 to 94%. In order to reduce the number of unnecessary benign biopsies, DCE-MRI may be used in ordinary clinical practice in combination with standard breast cancer detection. also

this show agreement with (18), who found that DTI is effective in characterizing changes in breast cancer, especially in high-risk subtypes like triple-negative breast cancer (TNBC). DTI's ability to provide detailed microstructural information on tissue anisotropy enhances its diagnostic accuracy, particularly in detecting invasive cancers that might be missed by traditional imaging.

Although this stud had some limitations, the study was carried out on a relatively small number of patients; however, a statistically significant difference was found suggesting that further prospective studies with a larger number of cases would be beneficial. Detailed lesion assessment in DTI was limited by technical issues related to the single-shot echo-planar imaging (EPI) technique due to its limited spatial resolution and its frequent artifacts. Also, the DTI sequence was time-consuming (the sequence time for 15 directions was about 10 min) with subsequent prolonged time of the whole MRI study to about 25–35 min. This time was not tolerated by all patients, especially obese or asthmatic patients. ROIs were manually defined on DTI maps for each exam after comparing DCE-MRI and DTI. Manual ROI is prone to operator dependence and sampling error, especially for irregularly shaped masses or non-mass enhancement. As a final limitation, only hospitals having access to the specialized imaging equipment used in the research might potentially benefit from its results. These machines might not be readily accessible in other healthcare facilities.

Conclusion

DTI can be used as an adjuvant sequence in diagnostic CE-MRI breast. While the DWI is still the most established diffusion parameter for differentiation between benign and malignant breast lesions, DTI may be helpful in further characterization of tumor microstructure which definitely needs further investigations. Values of FA was significantly higher in malignant than benign lesions, values of ADC and MD were significantly lower in malignant than benign breast lesions, breast DTI is a noninvasive method that demonstrated a high potential utility for cancer detection and serving as a stand alone techniques in conjunction with DCE-MRI, the discriminating values of FA were high. These measurements were strongly associated with identification of breast malignancy and combined evaluation by DTI parameters and DCE-MRI DTI enhanced the sensitivity, lowered the rate of false-negatives, and completely improved the accuracy of breast lesions differential diagnosis.

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Case Presentation

Malignant Group

case NO 1: female patient aged 51 years old presented with right breast lump and right bloody nipple discharge **(Figure 1):** (a) Axial T1WI pre-contrast shows low signal asymmetric retroareolar fibroglandular tissue. Axial T2WI lesion displays low signal

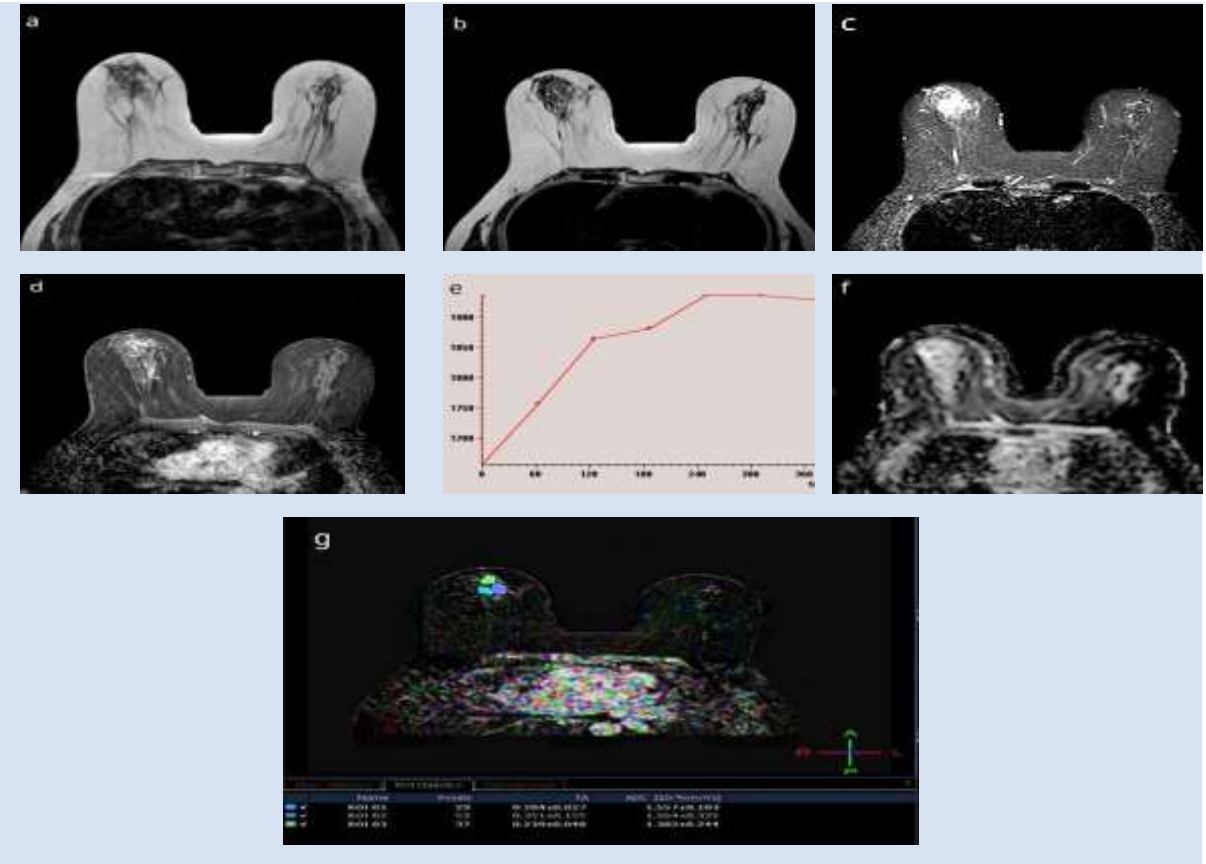
Axial STAIR images show right breast segmental retroareolar area of high signal

axial T1WI FS post-contrast show right breast linear non-mass enhancement seen in 12 o'clock region

kinetic curve: Type II, (f) DWI: The lesion displays high signal intensity, ADC value= 1.26 × 10−3 mm2/s (cut-of valueof<1.4× 10−3 mm2/s,.

(g) DTI FA value= 0.23 (cut-of value of>0.20), and MD value=1.06× 10−3 mm2/s (cut-of value of<1.19× 10−3 mm2).

Provisional diagnosis by DCE-MRI, diffusion and DTI parameters: Malignant lesion. Histopathological diagnosis: extensive high grade ductal carcinoma in situ together withltifocal grade II invasive duct cancer.



case NO 2: female patient aged 48 years old with positive family history of breast cancer, presented with right breast lump and right axillary mass

Figure 2: (a) Axial T1WI pre-contrast shows right breast RUQ Rounded mass with spiculated margins and low signal in T1, measured 48 x 32 mm and had an associated intraductal extension. Additionally, there was a posteriorly connected specule that reached the pectoral fascia and was around 30 mm long.

Axial T2WI lesion displays low signal

Axial STAIR images show intermediate signal with surrounding parenchyma high signal

axial T1WI FS post-contrast the mass appear heterogeneous enhanced

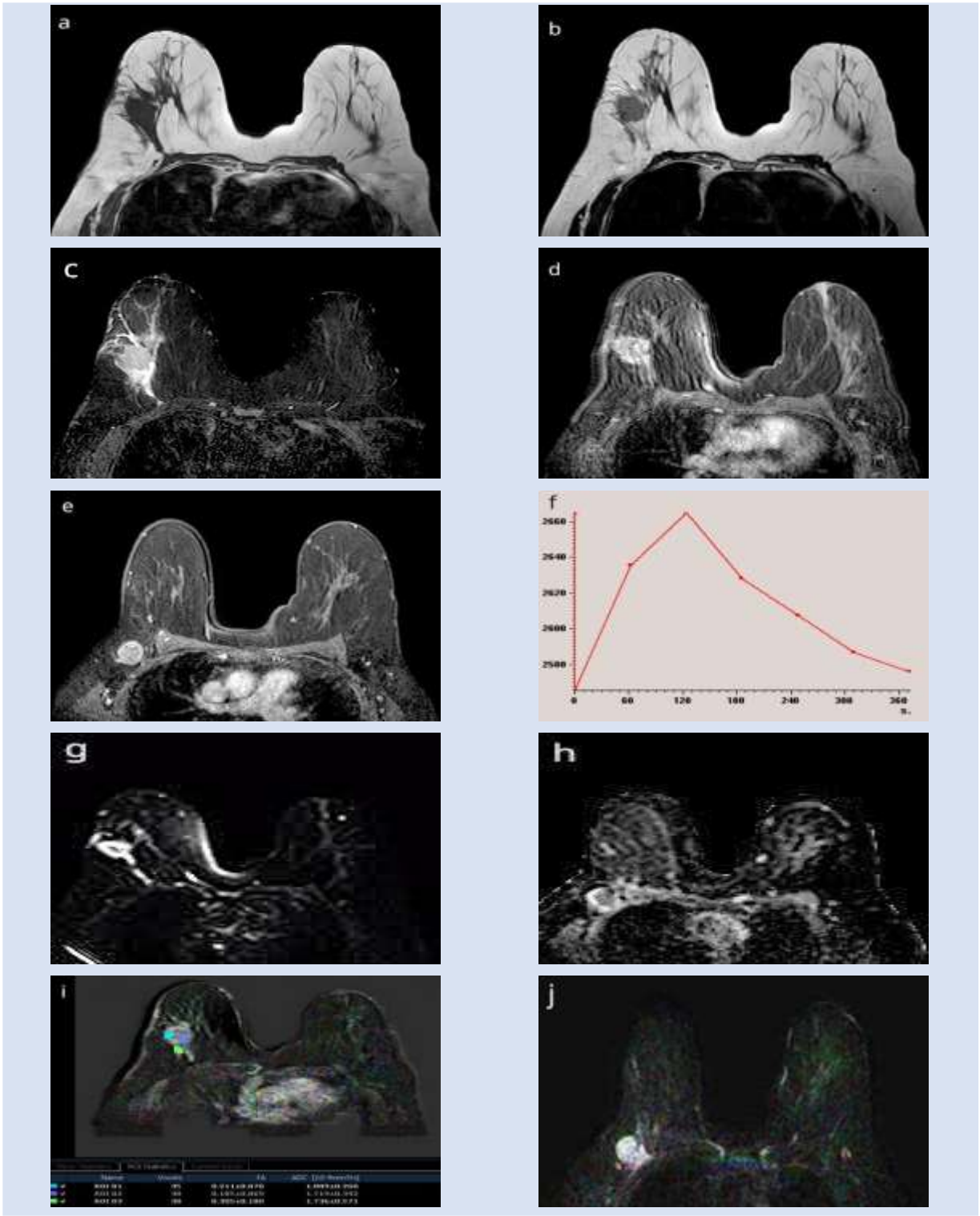
Axial T1WI postcontrast show heterogeneous enhanced right axillary LN

kinetic curve: Type III, washout curve

and (h) DWI show lesions in breast and axilla, both lesions display high signal intensity, ADC value= 1.72 × 10−3 mm2/s (cut-of valueof<1.5× 10−3 mm2/s,.

(i) and (j) DTI FA value= 0.21 (cut-off value of>0.15), and MD value=1.7× 10−3 mm2/s (cut-off value of<1.4× 10−3 mm2).

Provisional diagnosis by DCE-MRI, diffusion and DTI parameters: Malignant lesion. Histopathological diagnosis: grade III invasive duct cancer.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