DOI: https://doi.org/10.53350/pjmhs22161862

**ORIGINAL ARTICLE**

# Comparative Study of Diffusion-Weighted Imaging Versus Dynamic Contrast Enhanced-MRI in Diagnosis of Breast Tumors

HINA HANIF MUGHAL[1], HINA HAFEEZ ABBASI[2], FIZZA BATOOL[3]
[1]*Assistant Professor,Head of Radiology Department, Benazir Bhutto Hospital/ Rawalpindi Medical University*
[2,3]*Senior Registrar, Benazir Bhutto Hospital, Rawalpindi*
*Corresponding author: Hina Hanif Mughal, Email: dr.hinahanif@gmail.com, Cell: 03214249836*

## ABSTRACT

**Background and Aim:** Dynamic contrast-enhanced magnetic resonance imaging plays a significant role in the identification and characterization of breast tumors whereas Diffusion-weighted imaging (DWI) differentiates the benign lesions from malignant lesions. The present study aims to assess the diagnostic accuracy of dynamic contrast-enhanced MRI and diffusion-weighted imaging in the diagnosis of breast tumors.

**Methodology:** This cross-sectional study was conducted on 92 suspicious breast tumors patients underwent Diffusion-weighted imaging (DWI) and Dynamic contrast-enhanced magnetic resonance imaging in the department of Radiology of Holy Family Hospital and Benazir Bhutto Hospital, Rawalpindi from November 2020 to August 2021.DCE-MRI with DWI combination was subjected to morphologic and kinetic analyses. These findings were compared with standard histopathological findings.DWI values were used to calculate apparent diffusion coefficients (ADC). We compared the ADCs of benign and malignant lesions. Morphologic kinetic features and ADCs were evaluated together for the combined MRI protocol. DCEMRI, DWI, and combined MRI diagnostic values were computed. SPSS version 23 was used for statistical analysis.

**Results:**Out of 92 suspicious breast tumors, patients who underwent MRI, benign and malignant were 34 (37%) and 58 (63%) respectively. The overall mean age was 32.56±8.62 years with an age range of 20 to 70 years. Needle biopsy with percutaneous core was confirmed in all cases (BI-RADS≥3). The common malignant lesions were in upper outer quadrant 22 (37.9%), upper inner quadrant 11 (19%), lower outer quadrant 10 (17.2%), and lower inner quadrant 11 (19%). About 4 (6.9%) had malignant lesions in the retro areolar region. Based on quantitative diffusion coefficient measurement sensitivity, specificity, positive, and negative predictive value 94%, 81%, 89%, and 92% respectively for differentiating malignant tumors from benign. The sensitivity and specificity of DCE-MRI were 94% and 76% respectively. The combined sensitivity and specificity of DCE-MRI and DWI were 96% and 84% which was more significant than DCE-MRI and DWI alone.

**Conclusion:** Our study found that benign or malignant breast lesions can be identified and characterized with high sensitive multi-parametric MRI of breast. DWI and breast DCE-MRI both has comparable sensitivity. However, ascompared to DWI and DCE-MRI alone, the breast MRI had higher sensitivity and specificity in distinguishing malignant breast lesions from benign lesions.

**Keywords:** MRI breast, Dynamic Contrast-Enhanced (DCE)-MRI, Diffusion-Weighted Imaging (DWI)

## INTRODUCTION

Breast cancer is a major cause of morbidity and mortality. Breast cancer early detection is critical for the traditional intervention approach in managing carcinoma or disease. The palpable masses in the breast can be effectively diagnosed and managed with a triple assessment protocol. Routinely physical examinations, radiological investigations, and histopathological investigations are the triple assessment protocol for the diagnosis of breast lesions. Breast pathologies can be effectively diagnosed with imaging modalities such as ultrasound [1-3]. Triple assessment protocol had shown promising results in breast carcinoma diagnosis and breast malignancies prognosis [4, 5]. Numerous studies reported a promising role of dynamic contrast-enhanced (DCE)-MRI in the diagnosis of various types of breast lesions [6, 7]. Suspicious breast lesions can be evaluated by MRI as an established technique as compared to ultrasound and mammography. Although MRI is rarely used in suspicious biopsy diagnosis due to its inadequate specificity. However, MRI sensitivity in breast cancer diagnosis is as high as 90-100% for invasive carcinoma [8] whereas specificity is 72% which varies due to malignant lesions differences from benign lesions [9].

MRI early reports on breast lesions entirely relied on kinetic morphology of lesions enhancement [10]. Over the past few decades, breast MRI has been developed for improving positive predictive value (PPV) and increasing specificity in interpretation and strategy techniques of breast lesions. As per previous studies utilized new MRI technique, its specificity increased from 67% to 92% [11]. It continues to pique the interest of clinicians and researchers alike. Beside MRI, ADC and DWI imaging play a significant role in distinguishing malignant lesions from benign lesions. Also, it provides breast malignancies early identification and diagnosis. Breast carcinoma can be detected with DWI without or contrast injection adjunct especially in renal function test [12]. MRI provides more precise visualization of subsequent tissue of the breast, involvement of axillary lymph node, same and opposite breasts multiplicity, and evaluate the involvement of contiguous compared to conformist imaging, making it useful for carcinomas preoperative imaging. The goal of the present study was to evaluate the role of DWI and DCE-MRI differentiated benign lesions from malignant breast lesions.

## METHODOLOGY

This cross-sectional study was conducted on 92 suspicious breast tumors patients underwent Diffusion-weighted imaging (DWI) and Dynamic contrast-enhanced magnetic resonance imaging in the department of Radiology, Holy

Family Hospital andBenazir Bhutto Hospital, Rawalpindi from November 2020 to August 2021.DCE-MRI with DWI combination was subjected to morphologic and kinetic analyses. These findings were compared with standard histopathological findings. DWI values were used to calculate apparent diffusion coefficients (ADC). We compared the ADCs of benign and malignant lesions. Morphologic kinetic features and ADCs were evaluated together for the combined MRI protocol. DCEMRI, DWI, and combined MRI diagnostic values were computed.Prior to the conduction of the study, ethical approval was taken from the respective institutional ethics committee. Each patient provided informed consent in written form. Female patients diagnosed with breast lesions either with the presence of clinical or self-examination or breast lesions spotted through ultrasound were enrolled. A 1.5-T magnetic resonance imaging machine was used to examine all patients. All patients were examined prone with a dedicated breast coil. In premenopausal women, MR imaging was performed within 7–14 days of the menstrual cycle. Image acquisition was followed by image post-processing in the examination.

Patients with allergic reaction history to contrast media, previous interventional procedure, and contradictive magnetic resonance imaging were excluded. All metallic items associated with the patients' bodies were removed. Gadolinium contrast injection required intravenous access. The lesions were first detected using STIR images. On STIR and T1-weighted images, the morphologic features (shape and margins) of all detected lesions were examined. The DWI and DCE breast MRI sensitivity and specificity in the cancerous lesions sensitivity and specificity were calculated. The positive and negative predictive values were also computed. The SPSS 23.0 version was used for statistical analysis. To find connotation in categorical data, the Chi-squared test was used. A probability threshold of 0.05 was deemed significant.

## RESULT

Out of 92 suspicious breast tumors, patients who underwent MRI, benign and malignant were 34 (37%) and 58 (63%) respectively as shown in Figure-1. The overall mean age was 32.56±8.62 years with an age range of 20 to 70 years. Needle biopsy with percutaneous core was confirmed in all cases (BI-RADS≥3). The common malignant lesions were in upper outer quadrant 22 (37.9%), upper inner quadrant 11 (19%), lower outer quadrant 10 (17.2%), and lower inner quadrant 11 (19%). About 4 (6.9%) had malignant lesions in the retro areolar region. Based on quantitative diffusion coefficient measurement sensitivity, specificity, positive, and negative predictive value 94%, 81%, 89%, and 92% respectively for differentiating malignant tumors from benign. The sensitivity and specificity of DCE-MRI were 94% and 76% respectively. The combined sensitivity and specificity of DCE-MRI and DWI were 96% and 84% which was more significant than DCE-MRI and DWI alone. About 34 benign breast lesions were histopathologically diagnosedand Figure-3 illustrate the histopathologically diagnosed malignant 58 patients.Of the 34 benign lesions, prevalence of fibroadenomas, fibrocystic changes, mastitis, fat necrosis, postoperative scar, and postoperative seroma were 13 (38.2%), 5 (14.7%), 4 (11.8%), 5 (14.7%), 4 (11.8%), and 3 (8.8%) respectively. Out of 58 malignant lesions, the incidence of invasive duct carcinoma, invasive lobular carcinoma, and mucinous carcinoma were 41 (70.7%), 13 (22.4%), and 4 (6.9%) respectively as shown in Figure-3. Table-I displays the side and location of breast lesions in relation to histopathological findings. Table-II Displays the side and location of breast lesions in relation to histopathological findings whereas Compare the histopathological results in terms of lesion size.Table-III displays a comparison of histopathological results in terms of ADC.

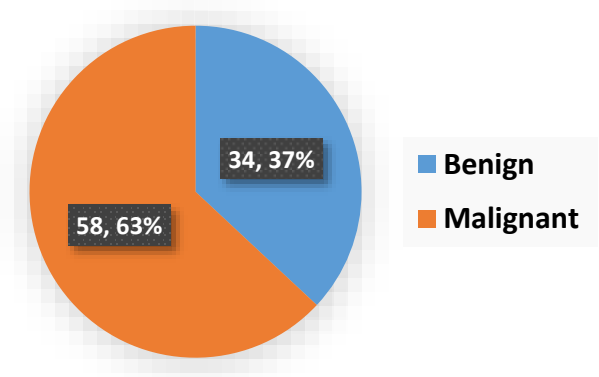


Figure 1: Prevalence of benign and malignant lesions or tumors

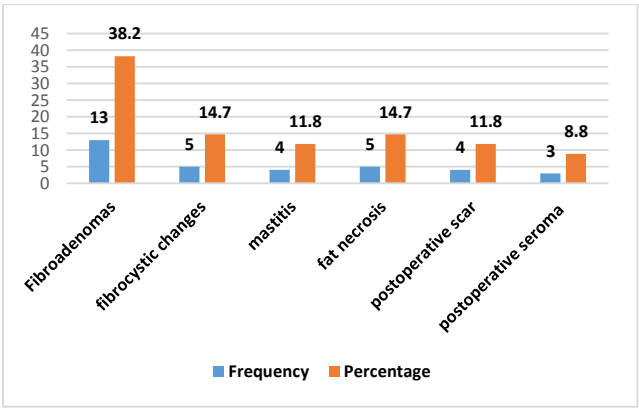


Figure 2: Prevalence of benign lesions

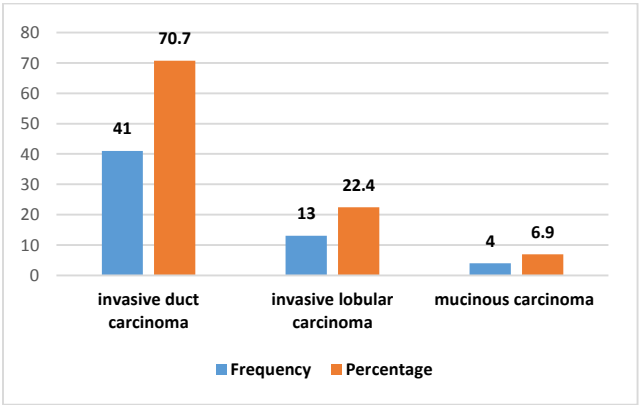


Figure 3: Prevalence of malignant lesions

Table 1: side and location of breast lesions in relation to histopathological findings

| Parameters | Benign N (%) | Malignant N (%) |
|---|---|---|
| Side | | |
| RT | 19 (55.9) | 32 (55.2) |
| LT | 15 (44.1) | 26 (44.8) |
| Location | | |
| Upper outer quadrant | 13 (38.2) | 32 (55.2) |
| Lower outer quadrant | 7 (20.6) | 5 (8.6) |
| Upper inner quadrant | 6 (17.6) | 4 (6.9) |
| Lower inner quadrant | 8 (23.5) | 3 (5.2) |

## DISCUSSION

Breast masses can be effectively detected with high capability magnetic resonance imaging of the breast. Besides costly imaging modalities, Breast MRI cannot be performed on patients with a history of contradictive MRI or intravenous contrast media reactivity history. The present study found that benign or malignant breast lesions can be identified and characterized with high sensitive multi-parametric MRI of breast. DWI and breast DCE-MRI both has comparable sensitivity. However, the sensitivity and specificity of breast MRI for distinguishing benign and malignant breast lesions improved when compared to DWI and DCE-MRI alone.Lee et al reported that breast parenchymal tissue presence in breast upper outer quadrant due to underarm cosmetic excessive usage could cause the breast cancer detected by Breast MRI [13], which resembled our findings regarding malignant lesions presence in the upper outer quadrant.

In the current study, well-defined and well-lineated mass lesions margins were benign mostly but speculated, and irregular lesion margins were diagnosed as malignant cases. According to Macura et al., [14] Breast MRI analysis had features of focal lesions margin description which diagnose and differentiate the benign from malignant lesions. Also, they reported that malignant lesions had irregular margins compared to benign lesions.

According to Rausch et al. [15], benign lesions can be distinguished from malignant lesions by lesion foal mass internal enhancement features. Shah et al, [16] reported that malignant lesions could be effectively diagnosed by heterogeneous internal enhancement morphological commonly seen among all the investigations whereas, in the current study, enhancement of DCE-MRI heterogeneous post-contrast revealed majority of cases of malignant lesions. In addition to precise lesions morphological characteristic's description, MRI contrast medium dynamic form signal intensified curve and inside signifying vascularity degree of the lesion [17].

Imamura et al.[18] found that kinetic curves intensity enhancement resulted in significantly improved distinction of benign from malignant breast lesions.The current investigation examined the ADC value using three distinct values. To differentiate malignant and benign breast lesions, various values of ADC had no significant differences or variances.Similar findings were established in a study by Chen et al. [18, 19], who discovered that the b values variations on DWI has no effect on the visibility of breast lesions. Partridge et al.[20] reported that DWI has aauspicious role in characterizing breast lesions and is not significantly limited by lesion size or type.Based on quantitative diffusion coefficient measurement sensitivity, specificity, positive, and negative predictive value 94%, 81%, 89%, and 92% respectively for differentiating malignant tumors from benign. The sensitivity and specificity of DCE-MRI were 94% and 76% respectively. The combined sensitivity and specificity of DCE-MRI and DWI were 96% and 84% which was more significant than DCE-MRI and DWI alone.

Both benign and malignant papillary lesions exhibit high cellularity and vascularization, which may complicate characterization at DCE-MRI and DWI [23-25]. Papillomas frequently exhibit restricted diffusion. There were few cases of benign intraductal papillomas in our study, and both showed restricted diffusion [26].The study's two mucinous carcinomas had higher mean ADC than the other types of breast cancer and even the benign tumors. This corresponded to the findings of a previous study [27].

The current study's limitations comprise a small number of patients due to the study's relatively short duration. There were fewer patients who met the inclusion criteria who were willing to undergo a diagnostic modality examination of breast MRI.

## CONCLUSION

Our study found that benign or malignant breast lesions can be identified and characterized with high sensitive multi-parametric MRI of breast. DWI and breast DCE-MRI both has comparable sensitivity. However, as compared to DWI and DCE-MRI alone, the breast MRI had higher sensitivity and specificity in distinguishing malignant breast lesions from benign lesions.

## REFERENCES


1. Elwakeel AM et al. Role of magnetic resonance imaging in differentiation of benign and malignant breast lesions. Menoufia Med J. 2018;31(2):502-7
2. Beerappa JR et al. Mammographic and sonomammographic evaluation of breast masses with pathological correlation: a prospective original study. Int J AnatRadiol Surg. 2016;5(3):9-12.
3. Youssef M et al. Role of MRI in differentiating benign from malignant breast lesions using dynamic contrast enhanced MRI and diffusion weighted MRI. Alexandria J Med. 2018;54(1):1-9.
4. Azzam H et al. The value of dynamic contrast-enhanced MRI in the diagnosis and management of triplenegative breast cancer. Egypt J RadiolNucl Med. 2020;51:26
5. DaimielNaranjo I, Lo Gullo R, Saccarelli C, Thakur SB, Bitencourt A, Morris EA, Jochelson MS, Sevilimedu V, Martinez DF, Pinker-Domenig K. Diagnostic value of diffusion-weighted imaging with synthetic b-values in breast tumors: comparison with dynamic contrast-enhanced and multiparametric MRI. European radiology. 2021 Jan;31(1):356-67.
6. Li Z, Li J, Lu X, Qu M, Tian J, Lei J. The diagnostic performance of diffusion-weighted imaging and dynamic contrast-enhanced magnetic resonance imaging in evaluating the pathological response of breast cancer to neoadjuvant chemotherapy: A meta-analysis. European Journal of Radiology. 2021 Oct 1;143:109931.
7. Partridge SC, Nissan N, Rahbar H, Kitsch AE, Sigmund EE (2017) Diffusion-weighted breast MRI: Clinical applications and emerging techniques. J MagnReson Imaging 45:337–355
8. PubMed Google Scholar

9. Iima M, Honda M, Sigmund EE, OhnoKishimoto A, Kataoka M, Togashi K (2019) Diffusion MRI of the breast: current status and future directions. J MagnReson Imaging. https://doi.org/10.1002/jmri.26908
10. Partridge SC, Newitt DC, Chenevert TL, Rosen MA, Hylton NM (2019) Diffusion-weighted MRI in multicenter trials of breast cancer. Radiology 291:546
11. PubMed Google Scholar
12. Amornsiripanitch N, Bickelhaupt S, Shin HJ et al (2019) Diffusion-weighted MRI for unenhanced breast cancer screening. Radiology 293:504–520
13. Runge VM (2017) Critical questions regarding gadolinium deposition in the brain and body after injections of the gadolinium-based contrast agents, safety, and clinical recommendations in consideration of the EMA's Pharmacovigilance and Risk Assessment Committee recommendation for suspension of the marketing authorizations for 4 linear agents. Invest Radiol 52:317–323
14. Dekkers IA, Roos R, van der Molen AJ (2018) Gadolinium retention after administration of contrast agents based on linear chelators and the recommendations of the European Medicines Agency. EurRadiol 28:1579–1584
15. Gulani V, Calamante F, Shellock FG, Kanal E, Reeder SB (2017) Gadolinium deposition in the brain: summary of evidence and recommendations. Lancet Neurol 16:564–570
16. Baltzer PAT, Bickel H, Spick C et al (2018) Potential of noncontrast magnetic resonance imaging with diffusion-weighted imaging in characterization of breast lesions: intraindividual comparison with dynamic contrast-enhanced magnetic resonance imaging. Invest Radiol 53:229–235
17. McDonald ES, Hammersley JA, Chou SH et al (2016) Performance of DWI as a rapid unenhanced technique for detecting mammographically occult breast cancer in elevated-risk women with dense breasts. AJR Am J Roentgenol 207:205–216
18. Shin HJ, Chae EY, Choi WJ et al (2016) Diagnostic performance of fused diffusion-weighted imaging using unenhanced or postcontrast T1-weighted MR imaging in patients with breast cancer. Medicine (Baltimore) 95:e3502
19. Bickelhaupt S, Laun FB, Tesdorff J et al (2016) Fast and noninvasive characterization of suspicious lesions detected at breast cancer x-ray screening: capability of diffusion-weighted MR imaging with MIPs. Radiology 278:689–697
20. Baltzer P, Mann RM, Iima M et al (2019) Diffusion-weighted imaging of the breast-a consensus and mission statement from the EUSOBI International Breast Diffusion-Weighted Imaging working group. EurRadiol. https://doi.org/10.1007/s00330-019-06510-3
21. Pinker K, Moy L, Sutton EJ et al (2018) Diffusion-weighted imaging with apparent diffusion coefficient mapping for breast cancer detection as a stand-alone parameter: comparison with dynamic contrast-enhanced and multiparametric magnetic resonance imaging. Invest Radiol 53:587–595
22. Zhou J, Chen E, Xu H et al (2019) Feasibility and diagnostic performance of voxelwise computed diffusion-weighted imaging in breast cancer. J MagnReson Imaging 49:1610–1616
23. Gatidis S, Schmidt H, Martirosian P, Nikolaou K, Schwenzer NF (2016) Apparent diffusion coefficient-dependent voxelwise computed diffusion-weighted imaging: an approach for improving SNR and reducing T2 shine-through effects. J MagnReson Imaging 43:824–832
24. O'Flynn EA, Blackledge M, Collins D et al (2016) Evaluating the diagnostic sensitivity of computed diffusion-weighted MR imaging in the detection of breast cancer. J MagnReson Imaging 44:130–137
25. Kul S, Metin Y, Kul M, Metin N, Eyuboglu I, Ozdemir O (2018) Assessment of breast mass morphology with diffusion-weighted MRI: Beyond apparent diffusion coefficient. J MagnReson Imaging 48:1668–1677
26. Avendano D, Marino MA, Leithner D et al (2019) Limited role of DWI with apparent diffusion coefficient mapping in breast lesions presenting as non-mass enhancement on dynamic contrast-enhanced MRI. Breast Cancer Res 21:136
27. Tamura T, Takasu M, Higaki T et al (2019) How to improve the conspicuity of breast tumors on computed high b-value diffusion-weighted imaging. MagnReson Med Sci 18:119–125