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ORIGINAL ARTICLE

Role of Diffusion MRI in Characterizing Benign and Malignant Breast Lesions

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ABSTRACT
Background: Diffusion-weighted MRI imaging (DWI) is frequently employed, particularly to assess organs such as breast, prostate, ovaries, liver, and pancreas.
Aim: The present study aimed to assess the diffusion MRI role in characterization benign breast lesions from malignant breast lesions.
Patients and Methods: This prospective study was conducted on 260 breasts lesions of 200 patients in the Department of Radiology, Jinnah Hospital Lahore and DHQ Hospital, Vihari from January 2021 to September 2022. Females (15 and 75 years) with breast lesion of diameter (>1cm) were enrolled. About 60 patients underwent breast MRI with contrast and DWI. The remaining 140 patients underwent DWI came for sonomammography. ADC values (b-vale 0-300, 0-600, and 0-1000) for all lesions were computed for differentiating the benign and malignant lesions. Benign and malignant breast lesions were categorized based on ADC values (1.3-1.5 mm^2/s) and (0.85-1.1 mm^2/s) respectively.
Results: Of the total 260 breast lesions, the incidence of benign and malignant breast lesions based on ADC values were 192 (73.8%) and 68 (22.2%) respectively. About 4 lesions were benign based on ADC value but were proven malignant after intervention. This approach of detecting malignant lesions based on ADC values has a specificity 100%, sensitivity 97.22%, positive prediction value 100%, and negative prediction value 99%. The ADC value of benign versus malignant breast lesions at b-value (0-300), (0-600), and (0-1000) were 1.56±0.23 vs. 0.82±0.21, 1.54±0.09 vs. 0.89±0.17, and 1.52±0.16 vs. 0.84±0.18 respectively.
Conclusion: The present study demonstrated that DWI for breast lesions had a good sensitivity and specificity for distinguishing benign from malignant lesions.
Keywords: Breast lesions, DWI, MRI, benign lesions, malignant lesions

INTRODUCTION
Diffusion-weighted MRI imaging (DWI) is frequently employed, particularly to assess organs such as breast, prostate, ovaries, liver, and pancreas [1]. Currently, breast lesions can be effectively diagnosed on MRI as an imaging modality. Substantial advancements in MRI technology have allowed for precise detection of cancer and anatomic characterization, as well as the use of MRI in numerous areas of breast cancer diagnosis and therapy [2]. According to certain research, DWI can distinguish between benign and malignant tumors [3]. Regardless of MRI dynamic contrast advancement, the benign lesions difference from malignant lesions is still challenging due to the kinetic aspects and morphological parameters [4]. The main criterion for DWI is the given voxel containing water molecules diffusibility using motion-probing gradients. T1 and T2 weighted MRI can be traditionally used for disintegrating the benign lesions from malignant lesions [5].

ADC normalization, obtained by dividing the ADC of the lesion by the ADC of normal glandular tissue, may decrease variance due to individual breast features and technical issues [6, 7]. Currently, women susceptible to higher risk of extreme breast lesion could be effectively assessed by weighted MRI used with mammography as an adjuncts for differentiating the breast lesions form malignant lesions [8]. Moreover, DWI and ADC readings are said to be beneficial in detecting breast cancer without the use of contrast material. As a consequence, DWI may be a feasible screening tool for patients of breast cancer with renal dysfunction [9, 10]. Since it quantitatively characterizes tumors, it is an alternative to invasive methods. Calculating a single ideal b-value can save up to eight examination minutes. DWI sequences allow for the identification and characterization of breast tumors in individuals who are not candidates for gadolinium-based contrast enhanced imaging. It has a significant positive predictive value for tumor response in neoadjuvant treatment and as part of a screening sequence for high-risk patients [10]. Therefore, the purpose of the present study was to assess the role of diffusion MRI in characterization of benign and malignant breast lesions.

METHODOLOGY
This prospective study was conducted on 260 breasts lesions of 200 patients in the Department of Radiology, Jinnah Hospital Lahore and DHQ Hospital, Vihari from January 2021 to September 2022. Females (15 and 75 years) with breast lesion of diameter (>1cm) were enrolled. About 60 patients underwent breast MRI with contrast and DWI. The remaining 140 patients underwent DWI came for sonomammography. ADC values (b-vale 0-300, 0-600, and 0-1000) for all lesions were computed for differentiating the benign and malignant lesions. Benign and malignant breast lesions were categorized based on ADC values (1.3-1.5 mm^2/s) and (0.85-1.1 mm^2/s) respectively. Benign and malignant breast lesions were categorized based on ADC values (1.3-1.5 mm^2/s) and (0.85-1.1 mm^2/s) respectively as shown in Table-I. MRI protocol was done on 1.5-T scanner by positioning the patients in disposed breast coil position. Axial DWI was done using single-shot echo-planar imaging (EPI) with b values of 0, 500, and 1000, TR/TE of 1800/75, FOV of 350 mm, and slice thickness of 3 mm. As a reference, faty glandular parenchyma with homogenous signal intensity on the ADC map was employed. The ADC values were calculated automatically by drawing ROIs. The ROI was 0.03 cm2 in size.

Table-1: Differentiation of benign and malignant lesions based on ADC value

Types of breast lesions	ADC value (mm^2/s)
Benign breast lesions	1.3-1.5
Malignant breast lesions	0.85-1.1

RESULTS
Of the total 260 breast lesions, the incidence of benign and malignant breast lesions based on ADC values were 192 (73.8%) and 68 (22.2%) respectively. About 4 lesions were benign based on ADC value but were proven malignant after intervention. This

approach of detecting malignant lesions based on ADC values has a specificity 100%, sensitivity 97.22%, positive prediction value 100%, and negative prediction value 99%. The ADC value of benign versus malignant breast lesions at b-value (0-300), (0-600), and (0-1000) were 1.56±0.23 vs. 0.82±0.21, 1.54±0.09 vs. 0.89±0.17, and 1.52±0.16 vs. 0.84±0.18 respectively. Figure-1 depicts the incidence of benign and malignant lesions. Table-I represents the ADC values in benign and malignant lesions.

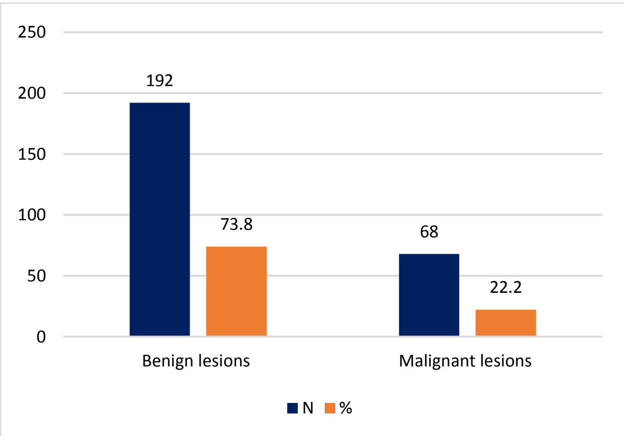

Figure-1: incidence of benign and malignant lesions

Table-2: ADC values in benign and malignant lesions

B-value	ADC value Benign breast lesions	ADC value malignant breast lesions
0-300	1.56±0.23	0.82±0.21
0-600	1.54±0.09	0.89±0.17
0-1000	1.52±0.16	0.84±0.18

DISCUSSION

The present study mainly focused on the MRI role in characterization of breast lesions and found that DWI is very important in breast imaging. ADC is a useful measure for identifying benign from malignant breast lesions. ADC fluctuated significantly when alternative b-values were used, indicating that absolute ADC threshold values should be regarded with caution. The Diffusion Weighted MR method improves the positive predictive value for breast lesion diagnosis and characterization. DWI should be included to the normal breast MRI regimen. DWI gives vital biological information on tissue composition, physical characteristics, and microstructure [11, 12].

In general, malignant lesions contain more closely compacted cells and lower ADC values as compared to the benign lesions. In dense malignant lesions, efficient water molecule mobility is inhibited, and diffusion is constrained. Lack of significant water diffusion restriction could be indicated by higher ADC values in cystic regions [13]. In cystic/necrotic cancers, false-negative readings can occur [14]. The ADC cut-off values for benign and malignant lesions was 1.3-1.5 x 10^{-3} mm^2/s and 0.85-1.1 x 10^{-3} mm^2/s respectively. These values permits the higher specificity and sensitivity for differentiating the malignant and benign breast lesions.

A previous research on 57 breast lesions by Zhang et al., reported that the ADC cut-off value was 1.20-0.25 x 10^{-3} mm^2/s [15]. Another study found that lower value of ADC was seen in malignant lesions cases [16]. Osman et al. investigated the use of contrast MRI in identifying breast cancer in 334 women [17]. The diffusion MRI specificity and sensitivity was 86% and 100% for distinguishing the malignant lesions from benign [18]. In a research to test the efficacy of DWI and MRI in lesion characterizations, Ibrahim et al. [19] discovered that the sensitivity was 92% and the specificity was 86% for distinguishing benign from malignant lesions which was comparable to a previous study [20].

Breast cancer is becoming more common among Pakistan's female population. Breast lesions are commonly detected by ultrasonography, mammography, and FNAC [21]. Breast tumors are now often detected by MRI utilizing specific breast coils. The current approaches for early identification of benign or malignant lesions use DW pictures with different b-values and then calculate ADC values [22].

CONCLUSION

The present study demonstrated that DWI for breast lesions had a good sensitivity and specificity for distinguishing benign from malignant lesions. ADC is a useful measure for identifying benign from malignant breast lesions. ADC fluctuated significantly when alternative b-values were used, indicating that absolute ADC threshold values should be regarded with caution. The Diffusion Weighted MR method improves the positive predictive value for breast lesion diagnosis and characterization.

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