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Significance of Diffusion Weighted Imaging and Apparent Diffusion Coefficient in Differentiation of Solid Breast Lesions.

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Abstract:
Background: *Breast neoplasms are common in women of all ages, especially during their reproductive age from the menarche to menopause.Breast cancer is the most common of all cancers in women and the leading cause of death due to cancer among women worldwide and the rates are higher in countries with majority of the population having a low-income.A recent study on the risk of breast cancer in India found that 1 in 28 women had breast cancer in their lives. This rate is higher in urban areas with a rate of 1 in 22 females compared to rural areas where the risk is relatively much lower with 1 in 60 women. The age range of the high-risk group in India is 43- 46 years; and this is unlike in the west, where women aged 53 – 57 years are more prone to breast cancer.[1] Early detection of lesions is the mainstay of treatment in today's world and mammography is widely used as a screening tool for the same. In addition, sonography has become a standard screening modality also. Sonography also plays an important role in image guided procedures such as needle aspiration cytology and core biopsy. MRI of the breast is also an important and advanced imaging modality, used for assessment of lesions both before and after administration of intravenous contrast agent. In this study we have used an extra sequence in MRI known as diffusion weighted imaging which requires no contrast administration to differentiate malignant from benign lesions.*
Materials and Methods: This study was carried out on 26 patients with clinically or ultrasonographically detected breast lesion.All patients were subjected to MRI of breast and the suspected lesion was sent for histopathology All the patients underwent MRI examination on a 3 T scanner (GE Signa HDxt scanner). An HD 8 channel VIBRANT dedicated breast array coil from GE was used in all patients. Before administration of contrast Axial T1 and T2, axial fat saturation T2, STIR T2, sagittal fat saturation T2, DWI and corresponding ADC of each breast was obtained.Using these raw data, post- processing was done with the help of a built-in software. In the post- processing subtracted images obtained
Results*: 26 lesions were detected , 13 were benign and 13 malignant. The sensitivity of DWI was 100% while specificity was 92.8% the ADC values for benign lesions were 1.1-2.2 x* $10^{-3}mm^2/sec$*, while malignant lesions showed ADC values of 0.46-0.99 x* $10^{-3}mm^2/sec$*. The ADC value of 1.1 x* 10^{-3} $mm^2/$ *sec can be used as cut off value for differentiating benign from malignant lesions.*
Conclusion: *DWI and ADC calculation are short unenhanced sequence that can be inserted into MRI protocols to accurately differentiate between the benign and malignant breast lesions.*
Key Word *Diffusion weighted imaging ;breast ;MRI*

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I. Introduction

Breast neoplasms are common in women of all ages, especially during their reproductive age from the menarche to menopause. The incidence of breast carcinoma in India is 19.1 per 100,000 women compared to 87 per 100,000 women in the UK and 101 per 100,000 women in the US.[2] India has one of the highest deaths per incident ratio at almost 50% compared to 30% in China and 18% in US. This is because majority of the patients in India present in stage 3 or 4; which could be due to lack of screening programs and/or lack of a culture of frequent self-examination of breasts along with general breast cancer awareness. Breast cancer is the most common cancer in urban areas in India and accounts for about 25% to 33% of all cancers in women.[3] If these percentages are converted into actual numbers, they are very high. Many studies have compared pre-operative breast MRI for local staging of breast cancer with mammography and ultrasonography. Orel et al[4] reported that MRI can detect cancers occult on mammography. Boets[5] in his comparative study of mammography, US and MRI in preoperative evaluation of breast cancer reported that while mammography showed 31% additional malignant breast lesions (which were not detected clinically), MRI detected 100% of them. Also, mammography

underestimated the tumour size but MRI correlated accurately with pathological tumour size. Several other studies subsequently demonstrated better accuracy of breast MRI compared to mammography in preoperative evaluation.

II. Material And Methods

This prospective comparative study was carried out on patients of Department of Radiodiagnosis and imaging at Yenepoya medical college hospital, derlakatte, mangalore, karnataka from august 2017 to November 2019. A total 26 females were included in the study.

Study Design: cross sectional study

Study Location: This was a tertiary care teaching hospital based study done in Department of Radiodiagnosis and imaging at Yenepoya medical college hospital, derlakatte, mangalore, karnataka.

Study Duration: August 2017 to November 2019.

Sample size: 26 patients.

Sample size calculation: The sample size is calculated by using the formula :

$$n = \frac{Z^2 d/2 \; s_p\hat{}(1-Sp\hat{})}{d^2(1-P)}$$

At 5 % level of significance $Zd/_2=1.96$

Sp=sensitivity =1.00 from the quoted reference literature

P=prevalence =62% from the reference literature

d=clinical significant difference =5%

The minimum sample size is 26.

Subjects & selection method: The study population was drawn from patients who presented to Tenepoya medical college hospital with with breast lump detected by examination or ultrasound from August 2017 to November 2019.

Inclusion criteria:

1. Patients suspected of having breast lesions by clinical examination and imaging by ultrasonography and/or mammography.
2. Patients with proven breast malignancy in the contralateral breast

Exclusion criteria:

1. Patient with claustrophobia;
2. Patients with metallic implants.

Procedure methodology

Patients were selected according of the inclusion criteria. Informed written consent was taken from each patient enrolling in the study. Clinically or ultrasonographically detected suspicious breast lesions were subjected to MRI and the imaging diagnosis including its dynamic contrast curve correlated with the histopathological report.

All the patients underwent MRI examination on a 3 T scanner (GE Signa HDxt scanner). An HD 8 channel VIBRANT dedicated breast array coil from GE was used in all patients. Before administration of contrast Axial T1 and T2, axial fat saturation T2, STIR T2, sagittal fat saturation T2, diffusion weighted images and corresponding ADC map of each breast was obtained.

BI-RADS Category	Assessment and Management
0	Incomplete: additional imaging evaluation needed
1	Negative
2	Benign
3	Probably benign: short interval follow up required
4	Suspicious: biopsy
5	Highly suggestive of malignancy: biopsy
6	Known malignancy: treatment on-going

III. Result

Based on the diffusion weighted imaging characteristics of the Index lesion the 26 patients studied were divided as 13 patients having benign lesion and 13 patients having malignant lesion.

Diagnosis on DWI/ADC	Present n (%)
Benign	13 (50.0)
Malignant	13 (50.0)
Total	26 (100)

Table 1: Diagnosis on MRI

COMPARISON OF MRI REPORT AND HISTOPATHOLOGY

On comparing the diffusion weighted images findings with the histopathology findings, we find that MRI had a sensitivity of 100 % and specificity of 92.8 %. The Positive Predictive value of MRI was at 92.3 % while the Negative predictive value of MRI was at a 100 %.

Comparison of MRI report and Histopathology report		Histopathology Report		Total
		Benign (n)	Malignant (n)	
MRI Report	Benign (n)	13 *True negative*	00 *False negative*	13
	Malignant (n)	01 *False Positive*	12 *True positive*	13
	Total (n)	14	12	26
	Measures	Specificity 92.8 %	Sensitivity 100 %	

Table 1: Comparison of MRI report and Histopathology report

Sensitivity of MRI Targeted HPE: 100 %
Specificity of MRI Targeted HPE: 92.8 %
Positive Predictive value: 92.3 %
Negative Predictive value: 100 %
True positives – 12 (Both MRI and Histopathology findings coinciding)
True negative – 13 (Both MRI and Histopathology findings coinciding)

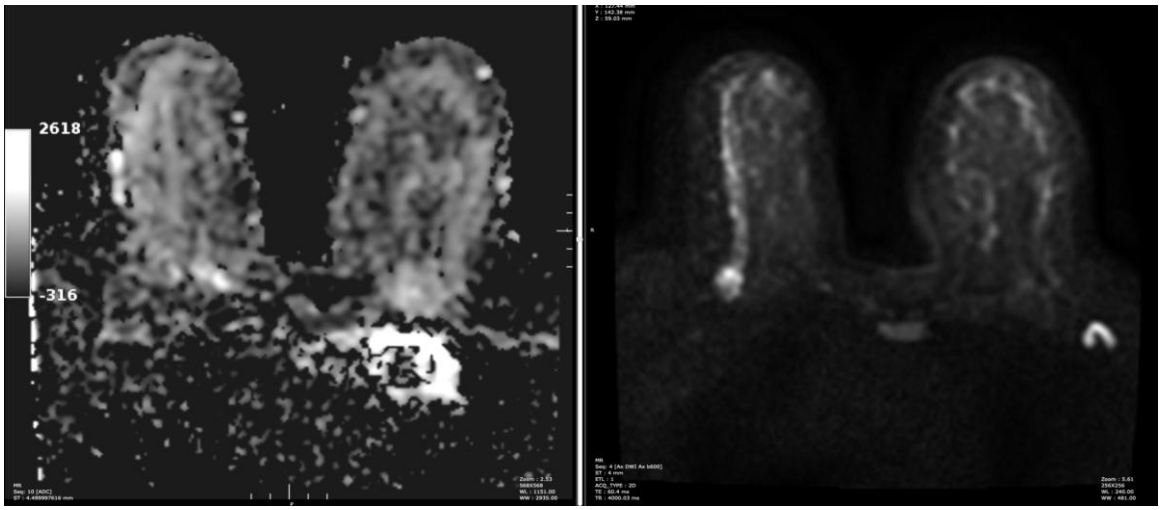

Image 1

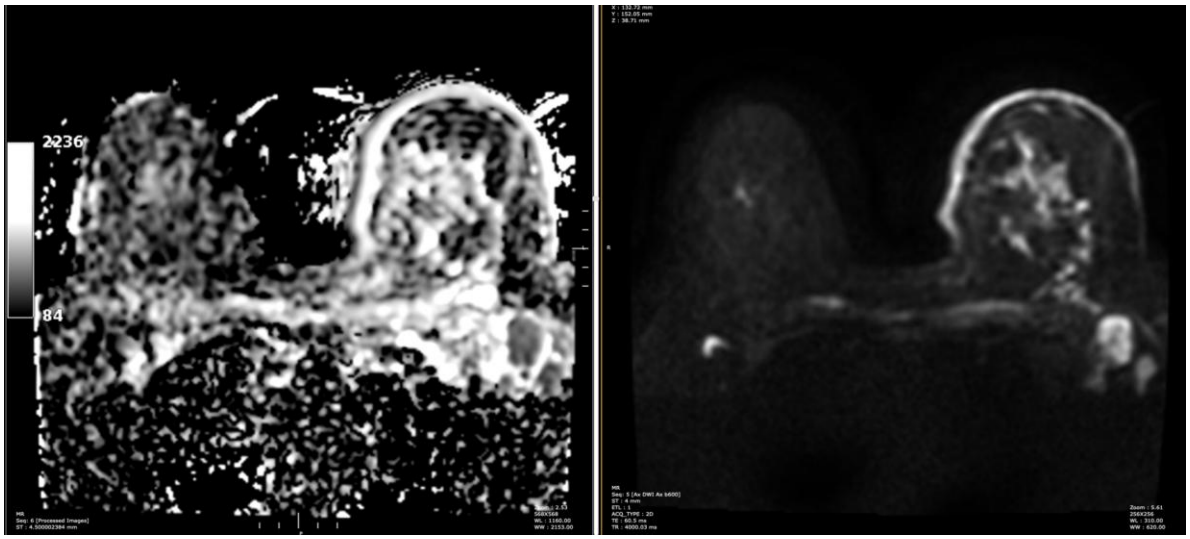

IMAGE 2

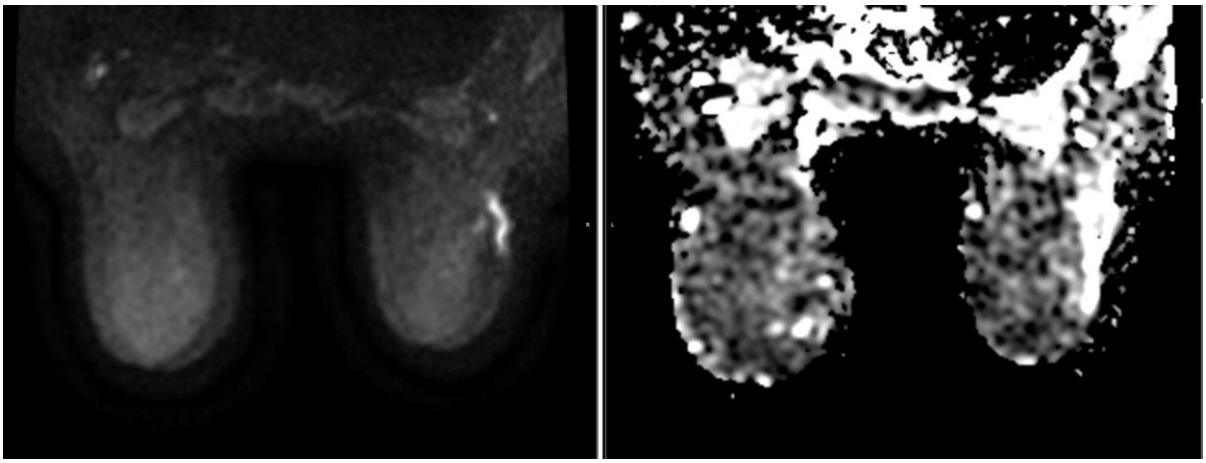

IMAGE 3

IV. Discussion

Breast cancer is a major cause of morbidity and mortality in women. A number of imaging strategies have evolved over time for patients with symptomatic breast cancer as well as for the screening of the population at risk. Diffusion weighted images carries very high sensitivity but moderate specificity for the diagnosis of breast cancer. DWI sequence has been widely used to improve the specificity of MRI in characterizing breast lesions. Our study was focusing on finding the effectiveness of MRI scan including DWI in identifying breast lesions accurately.

In the 26 patients we assessed using DWI images in our study, 13 patients were diagnosed to have benign lesions while 13 patients were diagnosed to have malignant lesions.

On histopathological correlation of these lesions, we found that all the patients diagnosed to have malignant lesions on imaging actually had malignant lesions and 12 out of the 13 patients diagnosed to have benign lesions on MRI had benign lesions. One lesion diagnosed as malignant on histopathological evaluation was given a benign diagnosis on MRI and classified as BIRADS III.

Fibroadenomas was observed in 8 patients and benign phyllodes, fibrosis, invasive lobar carcinoma, juvenile giant fibroadenoma, and papillary carcinoma were identified in 1 patient each. Intraductal carcinoma and invasive ductal carcinoma was present in 4 patients each. Similar findings has been found in other reviewed literatures also.[6,7 ,8,9]

In our study the MRI findings and Histopathology findings showed that the MRI had a sensitivity of 100 % and specificity of 92.8 %. The positive predictive value of MRI is 92.3 % and negative predictive value of MRI was at 100 %.

In the reviewed studies contrast enhanced MRI is increasingly being used for the detection and staging of breast cancer. MRI is better than mammography to define the tumour size and local extent of the primary breast cancers which has been seen in studies by Orel et al[5],. The sensitivity of breast MRI for detecting cancers

is very high at over 90%, as seen in studies by Orel et al[5], Fischer et al[6] and Wiener et al[7]. However, contrast enhancement on MRI is also seen in many benign conditions and hence specificity varies between 39% and 95% between studies by Fischer et al[124] and Huang et al[126]. Most of these findings in the reviewed studies and our studies have been similar.

V. Conclusion

We conducted this prospective study in Yenepoya medical college hospital under the department of Radiodiagnosis from November 2017 to May 2019 in which we tried to assess the diagnostic efficacy of diffusion weighted images in clinically and ultrasonographically detected breast lesions by evaluating its ability to differentiate between benign and malignant lesions. Twenty-six female patients, presenting to surgery department suspecting to have breast masses were included in the study.Diffusion weighted sequence was done and was found to be highly sensitive (100%) in detecting if the lesion is benign or malignant.As such, further in depth study maybe needed in larger cohorts of patients. DWI and ADC calculation are short unenhanced sequence that can be inserted into MRI protocols to accurately differentiate between the benign and malignant breast lesions.

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