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Original Research Article

Study of MRI Breast with Special Reference to Diagnostic Accuracy and Assessment of Multifocality of Carcinoma Breast

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Abstract:

Background: The existence and identification of multifocal and multicentric illness alters the ideal therapy strategy for breast cancer patients and considerably raises the chance of recurrence. With dense breast parenchyma, mammography has a low sensitivity to find numerous cancer foci in patients. We assessed magnetic resonance imaging (MRI) prospectively as a component of preoperative evaluation.

Methods: Women with dense breast parenchyma (> 75% dense tissue) and clinical and radiological suspicion of breast cancer were included. Prior to surgery, mammography, ultrasonography, and MRI were performed on each patient. Multicentric and multifocal disease was found using surgical tissues. Neo adjuvant chemotherapy and radiation patients were not included.

Results: 19 patients underwent evaluation. 14 patients had their histological diagnoses confirmed, and five and two patients, respectively, had multifocal and multicentric illness. For mammography plus ultrasound and MRI, the sensitivity and accuracy to identify multiple malignant foci were 42 and 64% and 100 and 92%, respectively ($p< 0.05$).

Conclusions: For women with dense breast parenchyma, MRI is more practical and more accurate than mammography plus ultrasound at identifying both multicentric and multifocal breast cancer. In this group of patients, MRI can enhance the preoperative assessment of breast cancer.

Keywords: Breast Cancer, Dense Mammary Parenchyma, Magnetic Resonance, Mastography, Ultrasonogram, Preoperative Stage, Multifocality, Multicentricity.

Introduction

In the glandular tissue of the breast, breast cancer develops in the lining cells (epithelium) of the ducts (85%) or lobules (15%). The malignant development is initially contained within the duct or lobule ("in situ"), where it often exhibits no symptoms and hasa low risk of metastasizing (spreading).

These in situ (stage 0) tumors may develop over time and migrate to the lymph nodes nearby (regional metastasis), other body organs (distant metastasis), or invade the breast tissue immediately around them (invasive breast cancer). Widespread metastases are the cause of breast cancer deaths in women.

Treatment for breast cancer can be quite successful, especially if the disease is discovered early. In order to treat the microscopic cancer that has spread from the breast tumor through the blood, breast cancer is frequently treated with a combination of surgical removal, radiation therapy, and medication (hormonal therapy, chemotherapy, and/or targeted biological therapy). Such treatment can stop the growth and spread of cancer, saving lives in the process.

2.3 million Women will receive a breast cancer diagnosis in 2020, and there will be 685,000 fatalities worldwide. The most common cancer in the globe as of the end of 2020 was breast cancer, which had been diagnosed in 7.8 million women in the previous five years. Worldwide, breast cancer causes more lost disability-adjusted life years (DALYs) for women than any other type of cancer. Every country in the globe experiences breast cancer in women after puberty at any age, albeit the incidence rates rise as people age. [1]

From the 1930s until the 1970s, there was no change in the mortality of breast cancer. In nations with early detection programs coupled with various forms of treatment to remove invasive disease, improvements in survival started in the 1980s.Breast cancer has been diagnosed earlier thanks to surveillance using both mammography

and clinical breast examination, which has also led to a rise in conservative surgical techniques.

The prevalence of several malignant foci in the breast ranges from 14 to 47%. To choose the optimal treatment course of action, it is crucial to rule out the presence of multifocal (affecting one quadrant) or multicentric (affecting two or more quadrants) disease. Multifocality (<5 cm) or multicentricity (> 5 cm) can also be determined by measuring the distance between malignant foci. [3]

Relapses following conservative surgery are common as a result of hidden malignant foci. [4,5] Moreover, compared to equivalent stages unifocal illness, breast cancer with multiple tumors is linked to higher nodal involvement. Additionally, these patients may now be classified as having an advanced stage based on the total of their multifocal tumors' diameters. [6]

The most crucial method for lowering the mortality rate from breast cancer is still screening mammography. Breast cancer that is in its early stages and clinically occult but treatable can frequently be found with mammography. Mammography is not a fool proof diagnostic, though, and it is less sensitive in people with dense breasts.7,8 Additionally, a greater proportion of dense tissue is linked to many malignant foci and a higher risk of breast cancer. [9]

Nuliparity in both premenopausal and postmenopausal women, late age at first pregnancy, younger age, low body mass index, and use of hormone replacement therapy are factors linked to an increased percentage of density (which measures the quantity of breast parenchyma in mammography). [10]

It has been demonstrated that magnetic resonance imaging (MRI) can detect breast tumors that are invisible to other screening methods, such as mammography. [11]

MRI offers a significant potential for screening high-risk cases, such as BRCA-positive patients, due to its capacity to imaging dense breasts.10-12 Breast MRI has demonstrated to result in a change in treatment in many cases due to the assessment of additional lesions in the contralateral breast or the assessment of multicentricity and multifocality when used in conjunction with routine imaging modalities in cases of highly worrisome findings. [11-13]

Although breast density has little to no impact on MRI in a diagnostic situation, its specificity can be variable and it has been linked to false-positive results that call for pointless biopsies and expensive, time-consuming follow-up tests. [14] In order to determine the effectiveness of MRI in detecting multifocal or multicentric disease in women with exceptionally dense breast parenchyma and clinically and radiologically suspected malignancy, we undertook a prospective research.

Material and Methods

This prospective study was conducted at Sumitram Hospital, Bidupur, Vaishali, Bihar. Included patients of this study refer to MRI at Radio-diagnosis department of Sri Krishna Medical College and Hospital, Muzaffarpur, Bihar by GE Signa Creator 1.5 Tesla Machine from September 2021 August 2022, of patients with percutaneously proven unilateral breast cancer and dense breast parenchyma to evaluate multifocal and multicentric disease by magnetic resonance imaging.

The following criteria were met by all patients: being considered for surgical treatment; having a breast MRI before undergoing tru-cut percutaneous biopsy performed by the same doctor, with subsequent pathology findings; tumor evidence by physical examination, mammography, and/or ultrasonography suggestive of cancer; mammography with extremely dense breast parenchyma according to the American College of Radiology Breast Imaging Reporting and Data System (BIRADS) 4 (>75% of dense tissue);15; and The same group of radiologists (S.O.M., Y.V.N., and T.F.C.) performed the USG and MRI. Nineteen patients in total were examined. Five patients were disqualified because there was no evidence of cancer in the surgical specimen or because they were candidates for Neoadjuvant chemotherapy because of signs of locally advanced disease (tumors more than 5 cm, lymph node involvement on physical examination, skin infiltration, inflammatory tumors, and candidates for surgery who required Neoadjuvant chemotherapy to shrink the tumor).

For descriptive reasons, categorical variables were reported as proportions with 95% confidence intervals and continuous variables as arithmetic means, medians, and standard deviations (error).

The Epidat 3.0 software calculated the sensitivity, specificity, positive and negative predictive values, accuracy, and 95% confidence intervals for the detection of multifocality or multicentricity by mammogram/ultrasound and MRI.

Fisher's exact test was used to compare clinical and radiological factors with the existence of multifocality or multicentricity in the histopathological report. $P < 0.05$ was used as the statistical threshold for significance in a two-tailed test. The data were analyzed using the SPSS software package, version 10 (SPSS Inc., Chicago, IL).

Results

Our study initially comprised 19 participants with a clinical suspicion of breast cancer. Due to the lack of malignancy (BIRADS 2 by MRI) or the need for neoadjuvant chemotherapy or radiotherapy, five individuals were disqualified. Table 1 displays the clinical and pathological features. The median age was 48± 2.9. 50% (7/14) of the patients had a positive family history of breast cancer, while only 29% (4/14) of the patients were premenopausal. Clinically and pathologically assessed tumors had median main dimensions of 2.2 and 2.5 cm, respectively. When evaluated before to surgery, 28.6% of patients were in stage I, 64.4% were in stage II, and 7.1% were in stage III. In 50% of cases, there was multifocal illness. 57.1% (8/14) underwent conservative surgery, while 42.9% (6/14) underwent radical mastectomy. There were no statistically significant differences between unifocal and multifocal/multicentric tumors and the clinicopathological features.

Table 1: Clinical and pathological characteristics of the patients

Characteristics	Values	Number
Age, year (Median ± SD)	48(±2.9)	14
Family history (%)	50%	7/14
Menopause (%)	71%	10/14
Site :		
UEQ	50%	7/14
UIQ	35%	5/14
IEQ	14.3%	2/14
IIQ	0	
Range (Median ± SD)	2.2(±0.2)	4/14
Positive ganglia	21.4%	3/14
Stage :		
I	28.6%	4/14
II	64.3%	9/14
III	7.1%	1/14
Treatment :		
Mastectomy	42.9%	6/14
Quadrantectomy	57.1%	8/14
Range of Pathology	2.5(±0.23)	14
Histologic Type :		
Ductal	85.7%	12/14
Lobular	14.3%	2/14
Tumor grade :		
I	21.4%	3/14
II	35.7%	5/14
III	42.9%	6/14
Estrogen receptor :		
Negative	50%	7/14
Positive	50%	7/14
Progesterone receptor :		
Negative	50%	7/14
Positive	50%	7/14
Multifocality	37.5%	5/14
Multicentricity	14.3%	2/14

UEQ: Upper External Quadrant. **UIQ:** Upper Internal Quadrant. **IEQ:** Inferior External Quadrant. **IIQ:** Inferior Internal Quadrant. **SD:** Standard Deviation.

Table 2: Detected foci of multifocal and multicentric breast cancer by mammography/ultrasound and RMI, Pathologic analysis of biopsy was used to confirm diagnosis

Multicentric and/or multifocal				
		Present	**Absent**	**Total**
Mamography/US	Positive	3	1	4
	Negative	4	6	10
	Total	7	7	14
MRI	Positive	7	1	8
	Negative	0	6	6
	Total	7	7	14

In comparison to MRI, which only missed one malignant foci, mammography and ultrasonography missed a total of 11 (Table 2). This foci was a ductal carcinoma, which lost its intrinsic vascularity and more than 20% of its borders with the rest of the parenchyma in the ultrasonographic image. The mastographic image for these foci darkened with the rest of the parenchyma. According to MRI results, the median sizes of missing malignant foci ranged from 25 to 50 mm (Table 3). None of the lesions underwent a second examination with ultrasound.

Table 3: Mastographic and ultrasonographic characteristics

Characteristic	Percentage	N
Mammography		
• Asymmetry	100%	14/14
• Undetermined margins	78.6%	11/14
• Architectural distortion	71.4%	10/14
• Suspicious calcifications	64.3%	9/14
• Thickening of the skin or adjacent tissue	64.3%	9/14
• Range, size of tumor (Median ± SD)	2.3(±0.18)	
• Positive ganglia	64.3%	9/14
Ultrasound		
• Undetermined margins	78.6%	11/14
• Heterogeneous	78.6%	11/14
• Vascularity	78.6%	11/14
• Thickening of the skin or adjacent tissue	71.4%	10/14
• Positive ganglia	64.3%	9/14
• Multicentricity/Multifocality	28.6%	4/14
Mammography/Ultrasound		
• BiRADS	14.3%	2/14
• BiRADS	85.7%	12/14

Consistently, contrast-enhanced MRI detected all types of breast cancer. In women with mammographically thick breasts, fat-suppressed three-dimensional and enhancement imaging modalities revealed previously unknown lesions (Figures 1-3) (Table 4). When cancers were first discovered by mammography and ultrasound and then quantified by MRI, the sum of all foci's diameters was substantially larger than that of the tumors (3.5 ±0.6 vs. 2± 0.21, $p < 0.05$).

However, no biopsy was performed using the MR picture as a guide, and no link between the lesions detected by MRI alone and their locationn or histologic type was found; rather, only multifocality and multicentricity were noted (Figure 4).

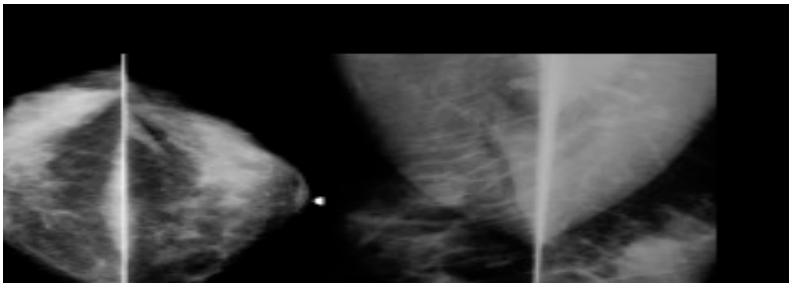

Figure 1: Mammograms showing a marked increase in density, a focal irregular density on the right side

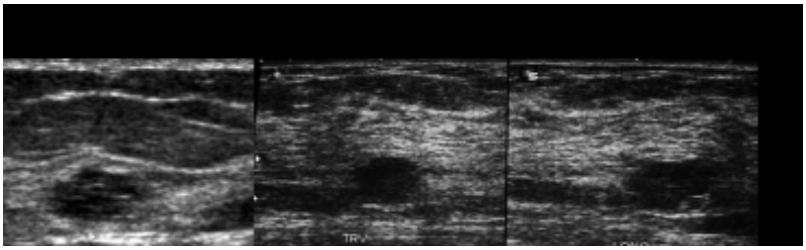

Figure 2: US image revealing corresponding hypoechoic solid masses, in the upper quadrant on the right breast

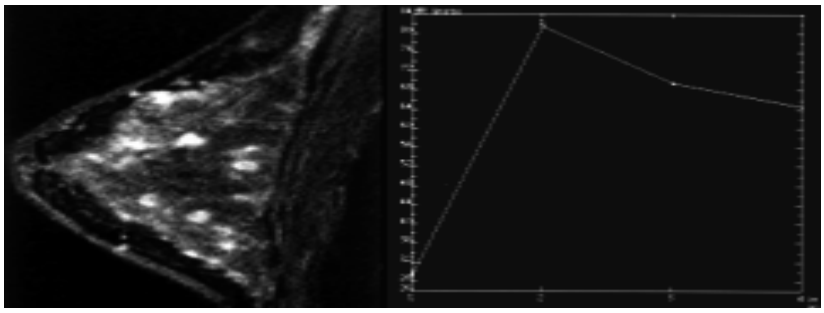

Figure 3: A. Sagital fat-suppressed contrast-enhanced 3D fast SPGR MR image (9.2/2.1) of the right breast showing multifocal areas of enhancement, suggestive of carcinoma. B. Followed by a strong washout

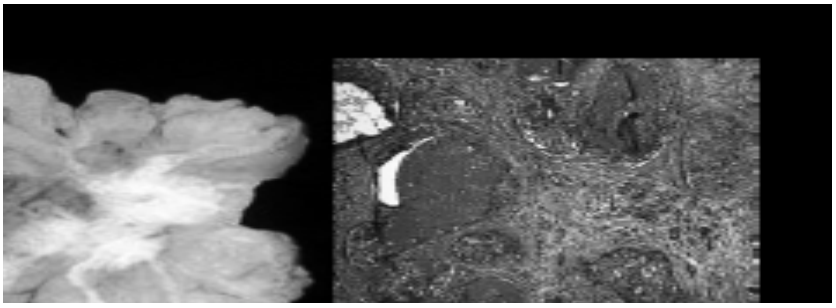

Figure 4: A. Macroscopic specimen shows multiple foci. B. Microscopic analysis of the isolated spicule showing heavy reactive fibrosis and tumor infiltration

Table 4: Characteristics of the patients in the breast-MRI

Characteristic	MRI	N
Lesion type		
• Regular	14.3%	2/14
• Irregular	85.7%	12/14
Margins		
• Regular	21.4%	3/14
• Spiculate	35.7%	5/14
• Irregular	50%	7/14
Enhancement		
• Ring-like	7.1%	1/14
• Homogeneous	14.3%	2/14
• Heterogeneous	64.3%	9/14
• Central	14.3%	2/14
• Enhanced internal septations	64.3%	9/14
• Without enhanced internal septations	35.7%	5/14
Visual Kinetic pattern		
• Progressive	0%	0/14
• Plateau	21.4%	3/14
• Wash out	78.6%	11/14
Multicentricity/Multifocality	71.4%	10/14
Median of the greater diameter of the tumor size of the malignant foci (unifocal) identified in Mammography/Ultrasound	2±0.21	14
Median of the diameter of all malignant foci	3.5±0.6	14

According to Table 5, MRI has higher sensitivity and better accuracy than mammography/ultrasound (100 vs. 42.9% p <0.05 and 92.8 vs. 64.3% p <0.05, respectively) when it comes to diagnosing multifocal/multicentric cancers. Between the two tests, specificity was comparable (85.7 vs. 85.7%, NS).

Table 5: Characteristics of mastography/ultrasound and MRI for multifocal and multicentric lesions

Characteristics	Mammography/US (CI 95%)	MRI (CI 95%)	P
Sensitivity	42.9(35.5-50.2)	100.0(92.9-100.0)	<0.05
Specificity	85.7(78.4-93.01)	85.7(78.4-93.0)	NS
Positive predictive value	75.0(62.2-87.7)	87.5(81.1-93.9)	NS
Negative predictive value	60.0(54.8-65.18)	100.0(91.6-100.0)	<0.05
Accuracy	64.3(60.6-68.0)	92.8(89.2-96.5)	<0.05

Discussion

The use of MRI as a breast cancer diagnostic technique is very new. Its function in treating this condition is currently developing. Our prospective study, which exclusively included women with dense breast parenchyma and clinical and radiological suspicion of cancer, compared MRI to mammography and ultrasound for the diagnosis of multifocal and multicentric illness. With only one false-positive test, three out of seven cases on mammography and ultrasound revealed multifocal illness. Multicentric and multifocal lesions that are hidden on mammography can be found with MRI. [19] Our findings are consistent with those that have been previously published, but we observed that ultrasonography and mastography have greater specificities. Additionally, there are no significant differences between the two, which may be because we only looked at individuals who had clinical and radiological suspicion of disease. In contrast to Van Goethem, who reported 20 patients with multifocal carcinoma, Sardanelli reported a sensitivity of 66% for mammography and 81% for MRI to detect foci of multifocal, multicentric breast cancer in dense breasts [19]. False-positive rates for these tests were 12.5, 14 and 23%, respectively. [20] Women who have been diagnosed with breast cancer in one location may also have cancer in the ipsilateral breast. 20-63% of tumors ≥ 2.5 cm in diameter had cancerous sites other than the index lesion, and 19-67% of these tumors were invasive, according to pathologic examinations of mastectomy tissues. Approximately 20–47% of mastectomy specimens reportedly have secondary malignant foci in quadrants other than the main tumor, according to other research. [19] With the rising global trend for conservative surgery and neoadjuvant chemotherapy, the characterization of these lesions and an appropriate staging of major importance to planning the treatment approach for breast cancer. [21]

In women with dense parenchyma and breast cancer, when mammography and ultrasound have the lowest sensitivity for detecting this pathology, this is even more important. [7] In a study with 557 individuals, Saarenmaa discovered that the sensitivity of mammography and ultrasonography was inversely related to age and directly related to breast fattiness. [9] Additionally, finding multifocal and multicentric tumors in breast cancer has effects on surgical planning as well as the likelihood of recurrence and the presence of positive ganglia. [21] Only 37.5% of the 848 women with unifocal illness had axillary ganglia involvement, compared to 52.1% of those with multifocal breast cancer.

The patient's disease may be reclassified into a more advanced stage based on the total of the size of multifocal tumors. [21] We discovered that the median diameter of multifocal tumors discovered by MRI was substantially less than the larger diameter of lesions identified by mammography and ultrasound. If the importance of the smaller foci on the incidence of positive ganglia and survival is disregarded, patients may not have access to neoadjuvant therapy. [22] According to these findings, MRI is substantially more sensitive than mammography for detecting several malignant foci in dispersed fibroglandular or very heterogeneous breast tissue. Compared to MRI, mammography misses larger, more aggressive cancer foci. [23]

Malignant foci found simply on MRI are still controversial, and further research is needed to determine their true clinical importance. [8] This study's shortcomings include the fact that the breast was not assessed as a whole even though the surgical specimens included 5 cm of margins free of disease. Breast-conserving surgery results in survival rates that are comparable to those obtained with mastectomy when paired with radiation therapy. [24,25] To determine the impacts of a more accurate assessment of the amount of disease on relapse and survival rates as well as quality of life, randomized studies comparing the outcomes of patients who underwent pretreatment MRI with a control group are required. [26-29] multiple malignant foci could indicate patients who would benefit from neoadjuvant chemotherapy or a non-conservative surgical strategy. [30]

Conclusion

In women with dense breast parenchyma, MRI is more reliable in determining multicentricity or multifocality without increasing the number of false-positive tests.

MRI is a superior preoperative research tool in this patient population.

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