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ROLE OF BREAST MRI IN DETECTION OF DUCTAL CARCINOMA IN SITU IN HIGH RISK BREAST CANCER PATIENTS

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ABSTRACT

Background: *Ductal carcinoma in situ (DCIS) is the most common form of non-invasive breast cancer, and its early detection is vital for improving outcomes, especially in high-risk populations. This study evaluates the effectiveness of breast magnetic resonance imaging (MRI) in identifying DCIS, focusing on its diagnostic accuracy compared to histopathology, the gold standard.*

Objective: *To Evaluate the breast Magnetic Resonance Imaging (MRI) in detecting Ductal Carcinoma In Situ (DCIS) lesions among high-risk breast cancer patients while keeping the histopathology as a GOLD standard.*

Results: *This prospective observational study at INMOL Lahore involved 40 high-risk breast cancer patients aged 30-60, assessing breast MRI's diagnostic performance through demographic, clinical, and histopathological analysis. Descriptive statistics and cross-tabulation were used for evaluation.The results showed that 75% of participants had positive MRI findings for DCIS, with histopathology confirming DCIS in 70% of cases. MRI demonstrated a sensitivity of 90% and a specificity of 70%. Non-mass-like enhancement was the most common imaging feature, seen in 60% of cases, followed by nodular enhancement in 25%. Most participants were classified as BI-RAD 6 (67.5%), indicating known malignancy. Risk factors included a family history of breast cancer (25%) and prior cancer diagnoses (58%).*

Conclusion: *These findings highlight MRI's high sensitivity in detecting DCIS, making it a valuable tool for early diagnosis in high-risk individuals, particularly those with dense breast tissue or genetic risk factors. However, the moderate specificity emphasizes the need for histopathological confirmation to minimize false-positive results. This study underscores the importance of integrating breast MRI into screening programs for high-risk populations. Further research with larger sample sizes and broader institutional involvement is necessary to improve imaging protocols and enhance diagnostic precision.*

Keywords: *Breast MRI, Ductal carcinoma in situ (DCIS), High-risk breast cancer, Early detection.*

INTRODUCTION

Cancer is one of the leading causes of mortality worldwide, claiming millions of lives annually. According to the World Health Organization (WHO), there are approximately 1.35 million new cases of breast cancer and 460,000 deaths globally every year. In the United States (US), there are 268,600 reported cases of breast cancer in 2019, making record high [1].Breast cancer,in particular, is the most frequently diagnosed cancer among women in the United States, excluding skin cancers, and accounting for nearly one-third of all new

female cancer cases each year. The American Cancer Society, projects nearly 300,000 new cases of invasive breast cancer and over 50,000 cases of ductal carcinoma in situ in 2023, with over 43,000 deaths expected in the United States alone.The goal of breast cancer screening programs is to decrease the rates of illness and death associated with breast cancer by detecting small, early-stage tumors, which allows for precise diagnosis and the best possible treatment [2]. Breast cancer remains one of the most prevalent and challenging cancer affecting women globally [3]. Data from the American Cancer Society also indicates a slow annual increase in breast cancer incidence rates of about 0.5% since the mid-2000s. Furthermore, since 2020, breast cancer has surpassed lung cancer as the most commonly diagnosed cancer in most countries (159 of 185), according to the International Agency for Research on Cancer [4].

Breast cancer develops due to the abnormal growth of cells within the breast tissue. The breast anatomy includes various components such as blood vessels, connective tissues, milk ducts, lobules, and lymph vessels. When cells in the milk ducts or lobules grow uncontrollably and divide abnormally, they can form a tumor. Tumors in the breast can be either benign or malignant.Benign tumors are the result of minor structural changes in the breast and are considered non-cancerous.In contrast, malignant tumors are cancerous and can be divided into two types: invasive and non-invasive.Invasive tumors(invasive carcinoma) spread to nearby tissues and organs, leading to complications,while non-invasive tumors (in-situ carcinoma) remain localized and do not affect surrounding structures. Early identification of breast cancer and accurate classification as benign or malignant is crucial to prevent further progression and complications. This enables timely and appropriate treatment, ultimately reducing the mortality associated with the disease [5].

Ductal carcinoma in situ (DCIS) is the most common type of non-invasive breast cancer, characterized by a range of atypical cell proliferations that are restricted to the ductal system and do not invade beyond the basement membrane [6]. Ductal carcinoma in situ (DCIS) is a heterogeneous condition made up of malignant epithelial cells that arise in the terminal ductal lobular units and remain confined within the basement membrane. Recognized as a precursor lesion, DCIS carries the potential to progress into invasive breast cancer. The advent of screening mammography for women over 40, introduced in the mid-1980s, has substantially improved early detection rates of DCIS, with sensitivity reported to range between 60% and 90%.In pure DCIS lesions, 59% exhibit non-nodular enhancement, while 14% show nodular enhancement, 14% do not show any enhancement, and 12% as a focal area of enhancement. On the other hand, 76% of lesions that involve both invasive carcinoma and DCIS demonstrate nodular enhancement [7]. Most screen-detected DCIS lesions are small, typically less than 15mm in size. The risk factors for developing DCIS are similar to those for invasive breast cancer and include having dense breast tissue, nulliparity, a personal history of atypical ductal or lobular hyperplasia, a family history of breast cancer, and BRCA1 and BRCA2 genetic mutations. Additionally, increased body mass index and the use of hormone replacement therapy are suggested as possible, though not definitively established, risk factors.DCIS typically appears on breast MRI as segmented or linear non-mass enhancement (NME), often with clumped internal enhancement morphology, seen in 60% to 80% of DCIS lesions visible on MRI. However, NME is not exclusive to DCIS, as it can also be observed in benign proliferative conditions (such as fibrocystic changes and pseudoangiomatous stromal hyperplasia), invasive breast cancer (both ductal and lobular types), and even in normal tissue (e.g, asymmetric physiological background parenchymal enhancement). Less commonly, DCIS may present as enhancing masses (14% to 34%) or small foci of enhancement (1% to 12%). The enhancement patterns of both DCIS and invasive carcinomas are influenced by tumor angiogenesis,with abnormal periductal or stromal vascularity. This can result from the disruption of myoepithelial cells, which normally secrete angiogenesis inhibitors and line the ducts [8].Several imaging modalities are employed for the detection of breast cancer, including mammograms (MGs), breast thermography (BT), magnetic resonance imaging (MRI), positron emission tomography (PET), computed tomography (CT), ultrasound (US), and histopathology (HP) [9].Breast imaging, particularly breast MRI, has significantly contributed to the advancements in breast cancer management [10].Breast MRI is recognized as the most sensitive imaging technique for detecting early-stage invasive breast cancer, particularly in women with dense breast tissue. Both the National Comprehensive Cancer Network (NCCN) and the American Cancer Society (ACS) recommend for MRI as a valuable adjunct to mammography, A standard breast MRI protocol typically

includes T1-weighted (T1W) contrast enhanced, T2-weighted (T2W) and diffusion-weighted (DWI). With advancements in MRI technology, dynamic contrast-enhanced (DCE) MRI and multiparametric (mp) MRI have become increasingly popular. However, MRI is a complex procedure that often produces over 1000 images. Radiologists must interpret these images from various sequences to provide a comprehensive diagnosis, a process that is time-consuming and susceptible to human error [11].Breast MRI is known for its high sensitivity, exceeding 90%, but its specificity remains moderate at around 72%, which complicates the differentiation between benign and malignant lesions. Since 2000, breast MRI has been widely adopted and has become a crucial tool in the screening, diagnosis, staging, and follow-up of breast cancer, particularly for high-risk patients. Breast MRI is valuable in high-risk screening, assessing unknown primary tumors, determining the local extent of disease, detecting multicentric and bilateral disease, especially in dense breast tissue, distinguishing between scar tissue and local recurrence post-breast-conserving surgery, evaluating the response to neoadjuvant chemotherapy, and assessing implant integrity [12].Diagnosis DCIS via MRI is often more challenging than diagnosis invasive carcinoma, as many distinctive features are absent. Regional or segmental enhancement in DCIS may be obscured by stippled enhancement caused by hormonal influences or fibro cystic changes. Additionally, DCIS lesions exhibit heterogeneous characteristics on MRI, reflecting the histopathological diversity of these tumors [13].

The aim of this study is to evaluate the role of breast MRI in detecting ductal carcinoma in situ (DCIS) among high-risk breast cancer patients. Specifically, the study seeks to determine the effectiveness of breast MRI in early identification of DCIS lesions, comparing its sensitivity and specificity to other imaging techniques. Additionally, the study aims to assess the impact of breast MRI on diagnosis accuracy, treatment planning, and outcomes for patients at high risk of breast cancer, ultimately aiming to enhance early detection and improve patient prognosis.The purpose of examining the role of breast MRI in detecting ductal carcinoma in situ (DCIS) among high-risk breast cancer patients is to understand how effective this imaging method is for early detection and diagnosis of DCIS lesions. The involves to evaluate the sensitivity and specificity of breast MRI compared to other diagnostic tools, as well as to determine its impact on treatment planning and overall patient outcomes in high-risk breast cancer populations.

The rationale for investigating breast MRI in detecting DCIS in high-risk breast cancer patients is based on its high sensitivity and detailed imaging capabilities, particularly beneficial in dense breast tissue. Conventional imaging methods often struggle with accuracy in these cases, leading to potential delays in detection. Early detection through breast MRI can significantly improve treatment planning and patient outcomes. Research supports its efficacy in screening, diagnosis, and monitoring, highlighting its crucial role in managing high-risk populations.

METHODOLOGY

Material And Methods include following items:

1. Research Design:

This study will employ a prospective observational design to assess the role of breast MRI in detecting DCIS among high-risk breast cancer patients.

2. Clinical Settings:

The study will be conducted at radiology department of Institute of Nuclear Medicine & Oncology (INMOL)

3. Sample Size:

40 patients of DCIS lesions among high-risk breast cancer patients

4. Sampling Technique:

Convenientt sampling Technique

5. Duration of Study:

06 months after the approval of synopsis

6.Selection Criteria:

6.1. Inclusion Criteria:

High-risk breast cancer patients with a family history of breast cancer or genetic predispositions (e.g., BRCA mutations).

Patients aged 30-65 years.

Patients willing to undergo breast MRI screening for DCIS detection.

6.2. Exclusion Criteria:

•Patients with contraindications to MRI imaging (e.g., pacemakers, claustrophobia).

•Patients with a history of prior breast surgery or interventions that may interfere with imaging interpretation.

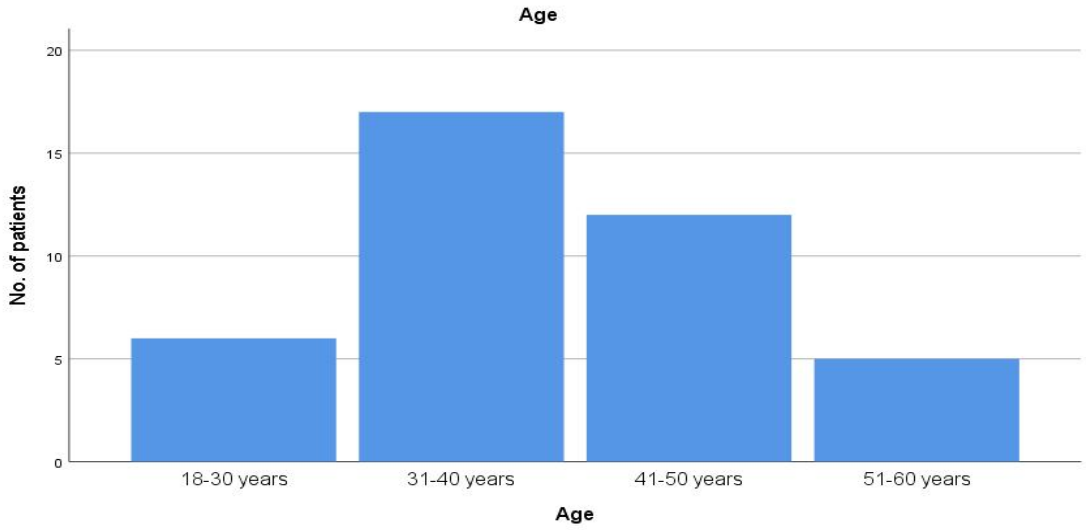
RESULTS

The study consist of 40 high-risk breast cancer patients, aged between 30-60 years. The majority (42.5%) were aged 31-40 years, followed by 30% aged 41-50 years were seen in table No 01

Table No. 01

Frequency of Age among Patients			
	Age	**No. of Patients**	**Percentage**
	18-30 years	6	15.0
	31-40 years	17	42.5
	41-50 years	12	30.0
	51-60 years	5	12.5
	Total	40	100.0

Figure No. 1

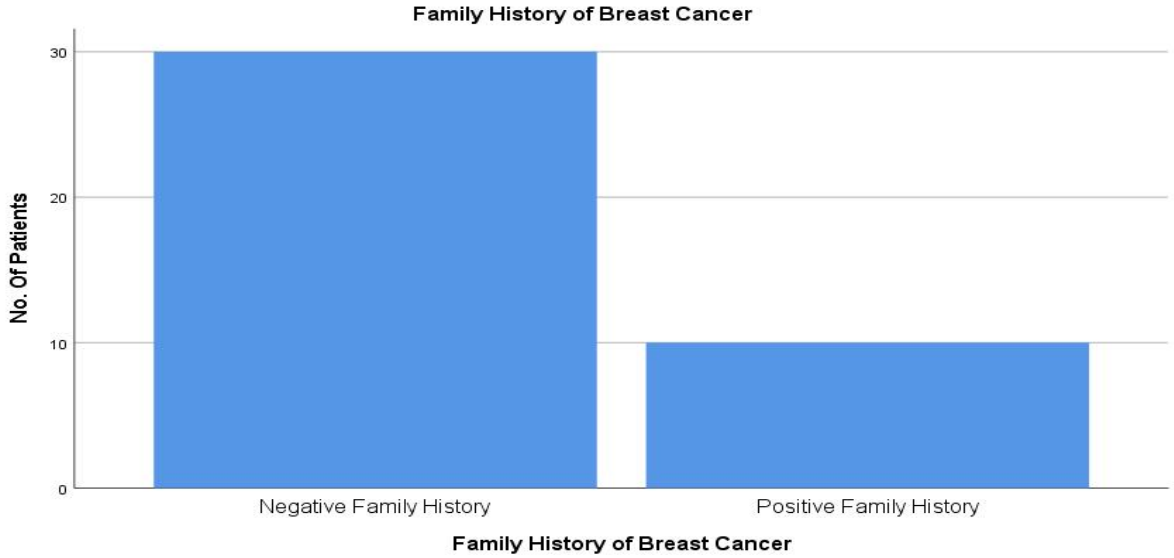


Family history of breast cancer was reported in 25% of participants, indicating a significant proportion of patients wit genetic predisposition were seen in table No. 2.

Table No. 02

Family History of Breast Cancer			
		No. Of Patients	Percentage
	Negative Family History	30	75.0
	Positive Family History	10	25.0
	Total	40	100.0

Figure No. 2

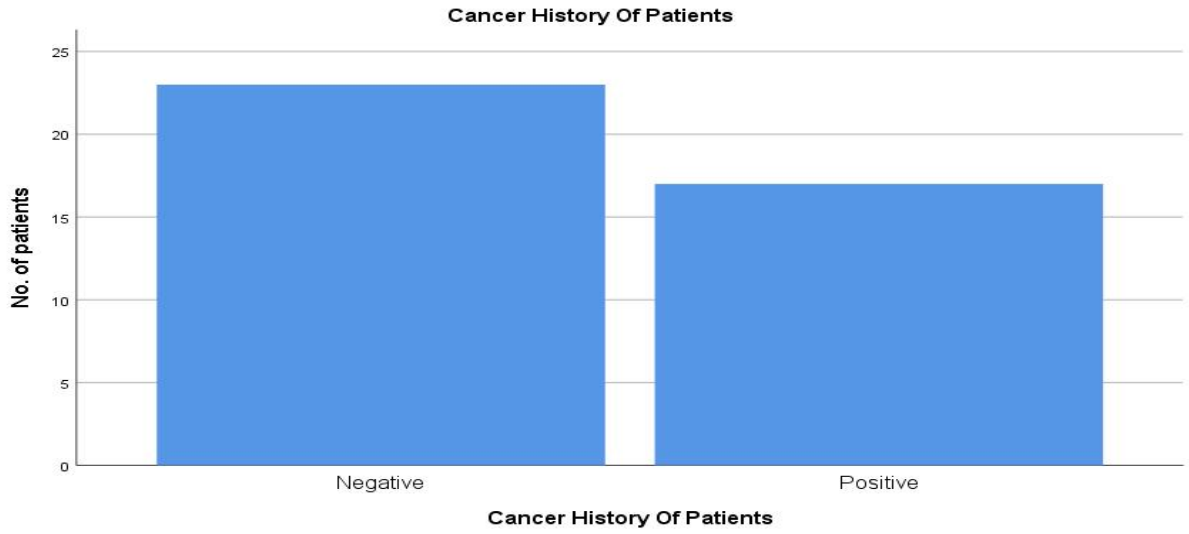


A total 23 patients (58%) reported a history of cancer and 17 patients patients (42%) had no history of cancer were shown in table No. 03

Table No. 03

Own History Of Cancer in Patients			
		No. Of Patients	Percentage
	Negative	23	57.5
	Positive	17	42.5
	Total	40	100.0

Figure No. 3

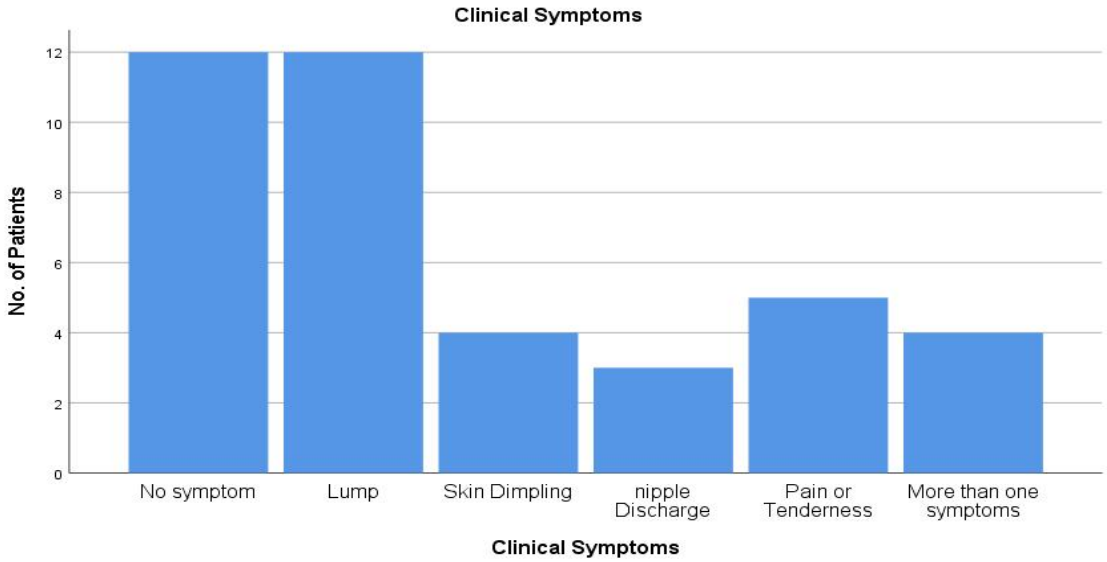


A total 12 patients (30%) reported a lump as their primary symptom, the second most common symptom was pain or tenderness, reported by 12.5% of patients. Skin dimpling and nipple discharge were less frequently observed, with 10% and 7.5% of patients, respectively, reporting these symptoms. 30% of patients reported no symptoms at all, while 10% of patients experienced more than one symptom.

Table No. 04

Clinical Symptoms			
		No. Of Patients	Percentage
	Lump	12	30.0
	Skin Dimpling	4	10.0
	Nipple Discharge	3	7.5
	Pain or Tenderness	5	12.5
	No symptom	12	30.0
	More than one symptoms	4	10.0
	Total	40	100.0

Figure No. 4

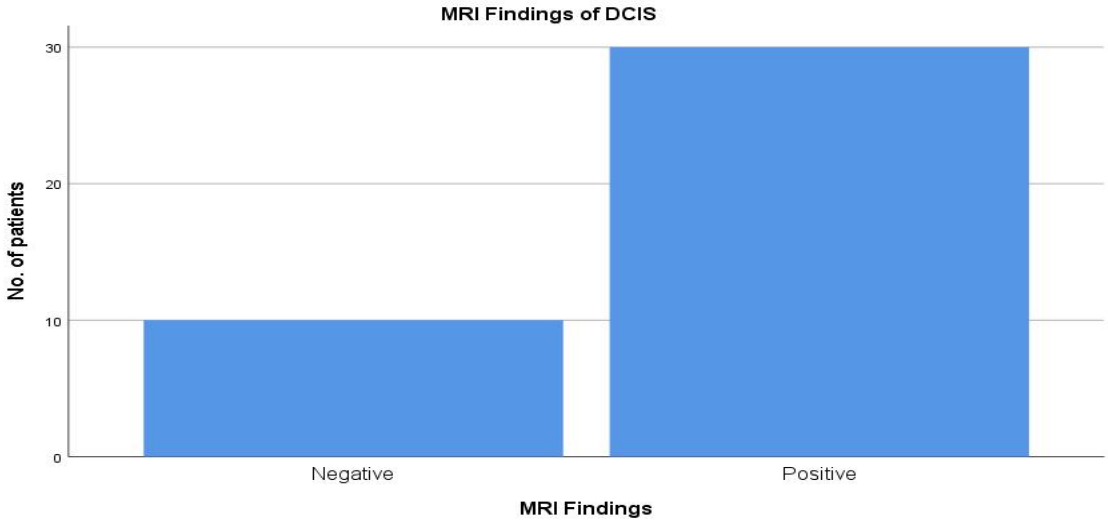


A total 30 patients (75%) reported a positive MRI findings of DCIS and 10 patients (25%) were a negative MRI findings of DCIS.

Table No. 05

MRI Findings			
		No. Of Patients	Percentage
	Negative (No DCIS)	10	25.0
	Positive (DCIS)	30	75.0
	Total	40	100.0

Figure No. 5

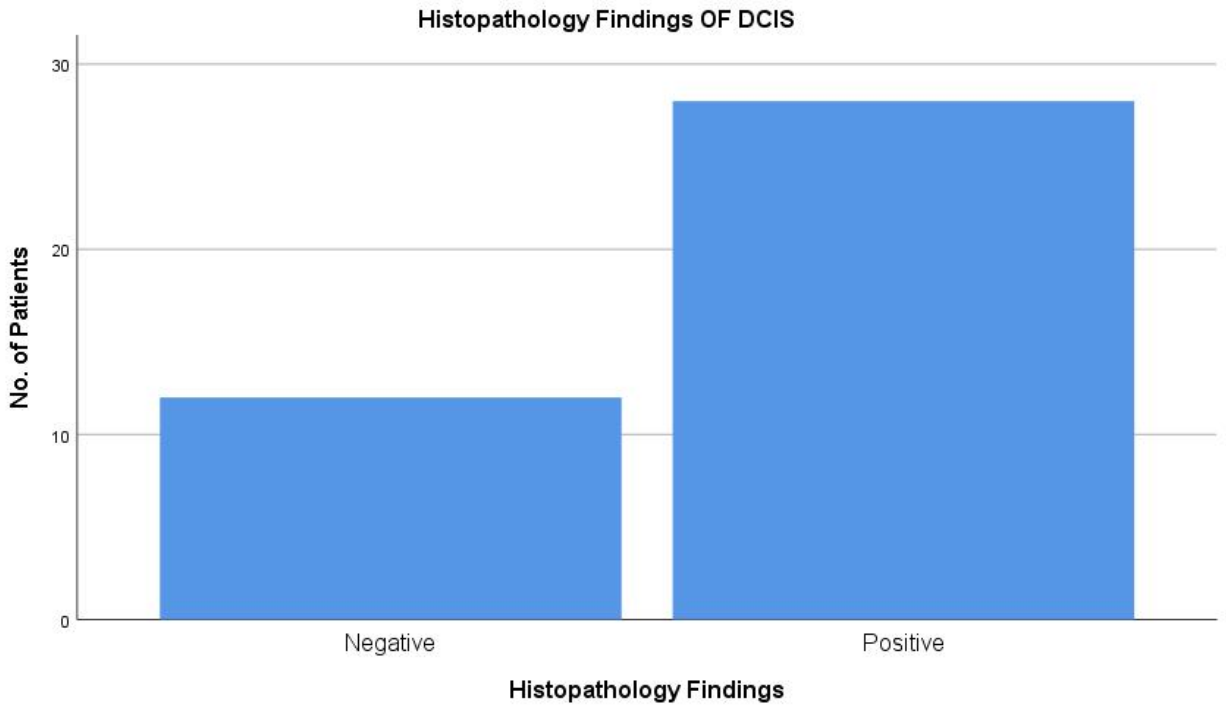


A total 28 patients(70%) reported a positive histopathology findings of DCIS and 12 patients (30%) were a negative histopathology finding of DCIS.

Table No. 06

Histopathology Findings			
		No. Of Patients	Percentage
	Negative (no DCIS)	12	30.0
	Positive (Histo proven DCIS)	28	70.0
	Total	40	100.0

Figure No. 6



The crosstabulation table shows the relationship between MRI findings and histopathology findings. Out of the 40 patients, 30 patients had positive MRI findings, of which 27 patients had a positive histopathological diagnosis of DCIS and 3 patients had a negative histopathological diagnosis (false positive) of DCIS. Additionally, 10 patients had negative MRI findings, with 9 patients having negative histopathological finding a 1 patient having a positive histopathological result (false negative).

Table No. 07

MRI Findings and Histopathology Findings Crosstabulation				
		Histopathology Findings		
		Negative	Positive	Total
MRI Findings	Negative	9	1	10
	Positive	3	27	30
Total		12	28	40

Chi square value is p= 0.003

This table shows the distribution of BI-RAD categories among the 40 study participants. The majority of patients (67.5%) were classified as BI-RAD 6, indicating known malignancy, while 25% were categorized as BI-RAD 5, suggesting high suspicious of malignancy. A smaller proportion , 7.5% of patients, were classified as BI-RAD 4, indicating suspicious abnormality.

Table No. 08

Bi-RAD

Bi-RAD Category		No. of patients	Percentage
	BI-RAD 4	3	7.5
	BI-RAD 5	10	25.0
	BI-RAD 6	27	67.5
	Total	40	100.0

This table shows the distribution of histopathology findings based on the family history of breast cancer. Out of 29 patients with a negative family history, 22 patients had positive histopathological findings, while 7 patients had negative histopathology results. Among the 11 patients with a positive family history, 6 patients had positive histopathology findings and 5 patients had negative results.

Table No. 09

Family History of Breast Cancer and Histopathology Findings Crosstabulation				
		Histopathology Findings		
		Negative	Positive	Total
Family History of Breast Cancer	Negative Family History	7	22	29
	Positive Family History	5	6	11
Total		12	28	40

Table No. 10

Lesion Characteristics Detected by MRI		
Lesion Type	**Frequency**	**Percentage**
Non-mass like enhancement	**24**	**60**
Nodular enhancement	**10**	**25**
Focal area of enhancement	**4**	**10**
No ehancement	**2**	**5**

DISCUSSION

Cancer is one of the leading causes of mortality worldwide, claiming millions of lives annually. According to the World Health Organization (WHO), there are approximately 1.35 million new cases of breast cancer and 460,000 deaths globally every year. In the United States (US), there are 268,600 reported cases of breast cancer in 2019, making record high [1].

Ductal carcinoma in situ (DCIS) is the most common type of non-invasive breast cancer, characterized by a range of atypical cell proliferations that are restricted to the ductal system and do not invade beyond the basement membrane [6]. Ductal carcinoma in situ (DCIS) is a heterogeneous condition made up of malignant epithelial cells that arise in the terminal ductal lobular units and remain confined within the basement membrane [7].

Breast imaging, particularly breast MRI, has significantly contributed to the advancements in breast cancer management [10]. Breast MRI is recognized as the most sensitive imaging technique for detecting early-stage invasive breast cancer, particularly in women with dense breast tissue [11].

Total 40 patients of DCIS at high risk breast cancer, aged between 30-60 years. The majority (42.5%) were aged 31-40 years, followed by 30% aged 41-50 years were seen in table No 01.Family history of breast cancer was reported in 25% of participants, indicating a significant proportion of patients wit genetic predisposition were seen in table No. 2.A total 23 patients (58%) reported a history of cancer and 17 patients patients (42%) had no history of cancer were shown in table No. 03.A total 12 patients (30%) reported a lump as their primary symptom, the second most common symptom was pain or tenderness, reported by 12.5% of patients. Skin dimpling and nipple discharge were less frequently observed, with 10% and 7.5% of patients, respectively, reporting these symptoms. 30% of patients reported no symptoms

at all, while 10% of patients experienced more than one symptom were shown in table No 4.A total 30 patients(75%) reported a positive MRI findings of DCIS and 10 patients (25%) were a negative MRI findings of DCIS were shown in table No 5. A total 28 patients(70%) reported a positive histopathology findings of DCIS and 12 patients (30%) were a negative histopathology finding of DCIS were shown in table No 6.The crosstabulation between MRI findings and histopathology findings. Out of the 40 patients, 30 patients had positive MRI findings, of which 27 patients had a positive histopathological diagnosis of DCIS and 3 patients had a negative histopathological diagnosis (false positive) of DCIS. Additionally, 10 patients had negative MRI findings, with 9 patients having negative histopathological finding a 1 patient having a positive histopathological result (false negative) were shown in table No 7. The distribution of BI-RAD categories among the 40 study participants. The majority of patients (67.5%) were classified as BI-RAD 6, indicating known malignancy, while 25% were categorized as BI-RAD 5, suggesting high suspicious of malignancy. A smaller proportion, 7.5% of patients, were classified as BI-RAD 4, indicating suspicious abnormality were shown in table No 8. The distribution of histopathology findings based on the family history of breast cancer. Out of 29 patients with a negative family history, 22 patients had positive histopathological findings, while 7 patients had negative histopathology results. Among the 11 patients with a positive family history, 6 patients had positive histopathology findings and 5 patients had negative results were shown in table No 9.

The majority of DCIS breast cancer patients in the study of Moon et.Al, (2007) were between the age of 30-67 year with the average age of 47 year [15]. In the study of lamb et.Al, (2020) were between the age of 28-89 year with the average age of 58 year [17].Similarly, In the study of Eric et.Al, (2007) were between the age of 23-86 year with the average age of 53 year [20]. In my study the the age between 30-65 year with the average age of 45 year.

The findings revealed that MRI demonstrates a higher sensitivity in detecting DCIS. In the study of Kuhl et.Al, (2007) shows that MRI have 98% sensitivity [14]. Similarly, in the study of Moon et.Al, (2007) shows that MRI have 94% sensitivity [15]. Baur et.Al, (2013) explains in their study that MRI have 79.3% sensitivity [16]. Additionally, my study explains 90% sensitivity of DCIS patients.

The findings of the study of Baur et.Al, (2013) regarding the characteristics of the lesions observed in high-risk breast cancer patients having Non-mass like enhancement and enhancing mass [16]. Similarly, in the study of Baur et.Al, (2007) regarding the characteristics of the lesions observed in high risk breast cancer patients having enhancing mass was the most common MRI manifestation for both pure invasive (79 ⁄ 101, 78%) and mixed lesions (163 ⁄ 216, 76%), but was demonstrated in only 9 ⁄ 64 (14%) of pure DCIS lesions. Conversely, NMLE was the most common MRI manifestation of DCIS, accounting for 38 ⁄ 64 (59%) pure DCIS lesions. NMLE was less commonly demonstrated in both pure invasive carcinoma and mixed lesions.[20].While in my study the majority of DCIS lesions (60%) appeared as non-mass like enhancements (NMLE). Nodular enhancement was noted I 25% of cases, while focal areas of enhancement accounted for 10%.

CONCLUSIONS

The conclusion of our study is to demonstrates that breast MRI is a highly sensitive tool for detecting DCIS in high-risk patients, with strong potential for improving early detection and treatment planning. Despite some limitations, the findings contribute valuable insights into the role of MRI in breast cancer detection and provide a basis for further research in this area.

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