International Medicine
www.theinternationalmedicine.org

Research Article

Section:Radiology

Impact of Breast MRI on BI-RADS 3 and 4 Sono-Mammography Lesions

Dr. Vedantkumar K. Kapadia*[1], Dr. Bhautik Kapadia[2], Dr. Kunal Vadwala [3] & Dr. Mehal Kamaliya[4]

[1] 3rd Year Resident, Department of Radiology, Medical College,Baroda

[2]Associate Professor, Department of Radiology, Medical College, Baroda

[3,4]Assistant Professor, Department of Radiology, Medical College, Baroda

ARTICLE INFO

Article History:

Received: 10-10-2024

Accepted: 12-11-2024

Key words:

Breast cancer

BI-RADS

MRI

Mammography

Ultrasonography

Diagnostic Accuracy

Breast Lesions

***Corresponding author:**

Dr. Vedantkumar K. Kapadia

3rdYear Resident, Department of Radiology ,Medical College, Baroda

ABSTRACT

Breast cancer is a global health challenge, with 2.3 million new cases and 670,000 deaths reported in 2022. The impact of breast cancer varies significantly based on healthcare access and socioeconomic factors. In high Human Development Index (HDI) countries, 1 in 12 women will develop breast cancer, and 1 in 71 will die from it. In contrast, low HDI countries see a higher risk of diagnosis (1 in 27) and mortality (1 in 48). In India, breast cancer made up 13.5% of all cancers and 10.6% of cancer deaths in 2020, underscoring the need for improved diagnostic strategies. While mammography and ultrasonography are key imaging methods for breast cancer detection, they have limitations, particularly in women with dense breast tissue. Dense tissue reduces mammogram sensitivity, making it harder to detect small or early-stage lesions. Breast MRI has emerged as a more sensitive tool, especially for women with dense breasts or those at high risk of breast cancer. MRI offers superior accuracy in detecting smaller lesions that mammography or ultrasound may miss. MRI is especially valuable in assessing BI-RADS (Breast Imaging-Reporting and Data System) 3 and 4 lesions. BI-RADS 3 lesions are likely benign but require follow-up, while BI-RADS 4 lesions are suspicious and usually require a biopsy. Accurate classification is crucial to reduce unnecessary biopsies and ensure timely treatment for malignant cases. This prospective study evaluates the diagnostic accuracy of MRI in classifying BI-RADS 3 and 4 lesions compared to mammography or ultrasonography, using histopathology results as the reference. The study aims to improve diagnostic precision and enhance breast cancer management, especially for Indian women with dense breast tissue.

INTRODUCTION

Breast cancer is a widespread disease affecting women worldwide, with 2.3 million new cases and approximately 670,000 deaths in 2022 alone [1]. It affects women of all ages, with its incidence increasing as they age. The disease's impact varies significantly between countries based on healthcare access and development levels[2]. In high Human Development Index (HDI) nations, 1 in 12 women will develop breast cancer, and 1 in 71 will die from it, while in low HDI countries, 1 in 27 women will be diagnosed, and 1 in 48 will die[3]. Breast cancer incidence refers to the number of new cases within a population, while the age-standardized incidence rate (ASIR) adjusts for age differences, allowing for fair comparison. Similarly, the age-standardized mortality rate (ASMR) adjusts death rates for age[4]. In India, breast cancer is the most common malignancy among women. Between 1990 and 2016, the age-standardized incidence rate rose by 39.1%, with the number of new cases expected to exceed 2 million by 2030, highlighting the growing burden of this disease[5].

According to Globocan 2020, breast cancer accounted for 13.5% (178,361) of all cancer cases and 10.6% (90,408) of cancer deaths in India, with a cumulative risk of 2.81%. Mammography and ultrasonography are the primary imaging methods for detecting malignancies and evaluating breast abnormalities[6]. Mammography remains the standard for screening but has limitations in specificity, sensitivity, and predictive value. Ultrasonography is widely used, particularly in younger women or those with dense breasts, often as an adjunct to mammography [7]. However, both methods face challenges in detecting small lesions and differentiating cysts from solid masses. Breast MRI has become the most sensitive tool for detecting breast cancer, especially in dense breast tissue, offering a

non-ionizing radiation alternative[8]. It is particularly useful for evaluating breast implants and invasive cancers. MRI detects smaller cancers, with 69% being under 1 cm, improving early diagnosis, downstaging, and survival rates. It also effectively identifies non-calcifying ductal carcinoma in situ (DCIS), which mammography often misses.The American College of Radiology (ACR) developed the Breast Imaging-Reporting and Data System (BI-RADS) to standardize breast lesion descriptions, reduce variability between radiologists, and improve communication with clinicians, ultimately enhancing patient care [9]. BI-RADS classifies breast lesions into seven categories (0 to 6), each representing a different probability of malignancy and guiding treatment decisions. MRI plays a key role in evaluating BI-RADS 4 lesions, which are suspicious abnormalities that require biopsy but do not meet classic malignancy criteria. MRI helps differentiate between benign and malignant lesions non-invasively, potentially avoiding unnecessary biopsies[10]. It can also accurately stage cancer when malignancy is confirmed, aiding treatment planning. This prospective, single-center study aims to evaluate the utility of MRI in assessing breast lesions categorized as BI-RADS 3 or 4 based on mammography or ultrasonography in Indian women. By comparing MRI findings with histo pathology, the study seeks to clarify MRI's role in refining BI-RADS categorization and improving breast cancer mana gement [11].This prospective study aims to assess the diagnostic accuracy and clinical utility of breast MRI in detecting and characterizing breast lesions. It focuses on refining BI-RADS categorization for indeterminate lesions (BI-RADS 3 & 4) identified on mammography or ultrason ography. The study compares the sensitivity, speci ficity, positive predictive value, and negative predictive value of MRI with other imaging modalities. Additionally, MRI findings will be correlated with histopathology results to enhance the overall management of breast cancer and benign lesions.

OBJECTIVE / AIMS

This study aims to assess the diagnostic accuracy and clinical utility of breast MRI in detecting and characterizing breast lesions. It will clarify the BI-RADS categorization of indeterminate findings (BI-RADS 3 and 4) from mammography and ultrasonography using breast MRI. Additionally, the study will compare the sensitivity, specificity, posi tive predictive value, and negative predictive value of breast MRI against other imaging modalities, such as mamm ography and ultrasound, for identifying breast cancer and benign lesions. Finally, it will correlate MRI findings with histopathological results to enhance diagnostic precision.

MATERIAL AND METHODS

This prospective study was conducted at the Department of Radiology, Medical College Vadodara and S.S.G. Hospital from January to August 2024, involving 25 patients with 27 suspected breast lesions. An ethical approval has been obtained from the Ethical Approval Committee. Patients presented with BI-RADS 3 or 4 lesions on sonoma mmography, and those who were pregnant, clinically unstable, or had contraindications to MRI were excluded. Imaging procedures included mammography and ultrasound, performed using the Allengers VENUS MAM and Samsung RS 80 EVO machines, respectively. MRI scans were conducted using the MAGNETOM SEMPRA 1.5 Tesla MRI machine with a 16-channel breast coil. The findings from each imaging modality were compared, with lesion characteristics analyzed and correlated with histopathology reports to assess diagnostic accuracy and refine BI-RADS categorization.

RESULT

In our study of 25 patients across various age groups, 1 patient (4%) was aged ≤20, 9 patients (36%) were aged 21-40, and 13 patients (52%) fell into the 41-60 age group, making this the largest cohort. Only 2 patients (8%) were older than 60. The mean age was 44.28 years, with a standard deviation of 2.39, spanning an age range of 16 to 70 years. This suggests that most patients were near the average age, with limited variation. The majority of participants were aged 41-60, representing over half of the study population.

Table 1: Comparative Analysis of Breast Composition Assessment

Breast Composition	Mammography	Ultrasound	MRI
a-Almost entirely fat	4	10	14
b-Scattered fibroglandular	11	10	6
c-Heterogeneous fibroglandular tissue	6	5	2
d-Extreme fibroglandular tissue	4	-	3

The table shows breast composition types and detection rates for mammography, ultrasound, and MRI. In "almost entirely fat," MRI detected 14 lesions, compared to 4 for mam -mography and 10 for ultrasound. MRI had lower detection rates for fibroglandular tissues, but was most accurate in fatty compositions.

Table 2: Comparative Analysis of BIRAD Scores from Sono -Mammography and Histopatholgy Findings

Birad Score Sono-Mammography	Histopathology				Total
	Benign	Malignant	Inflammatory	Inefctive	
III	1	0	3	1	5
IV	1	1	0	1	3
IV A	3	4	1	0	8
IV B	0	2	0	0	2
IV C	2	6	0	0	8

In our study comparing BI-RADS scores from sonom ammography with histopathology, lesions categorized as BI-RADS III showed 3 inflammatory, 1 benign, and no malignancies. Higher categories revealed increasing malig- nancy rates, emphasizing breast ultrasound's role in iden tifying potential cancers and potentially reducing unnece- ssary biopsies in lower BI-RADS classifications.

Table 3: Comparative Analysis of BIRAD Scores from MRI and Histopathology Findings

Birad Score MRI	Histopathology				Total
	Benign	Malignant	Inflammatory	Infective	
II	0	0	0	1	1
III	5	0	4	1	10
IV	2	1	0	0	3
V	1	12	0	0	13

In our study comparing MRI BI-RADS scores with histopathology, the findings showed: BI-RADS II had 1 infective lesion; BI-RADS III included 5 benign, 4 inflammatory, and 1 infective lesion, with no malignancies; BI-RADS IV had 2 benign and 1 malignant lesion; and BI-RADS V had 12 malignant and 1 benign lesion. These results emphasize MRI's effectiveness in distin guishing malignancies, especially in higher BI-RADS categories, and in confirming benign conditions, thereby aiding clinical management.

Table 4: Diagnostic Accuracy of MRI and Sono Mammography in Breast Pathologies

Modality	Sensitivity	Specificity	PPV	NPV
Sonomammography	100%	38.46%	61.90%	100%
MRI	100%	78.57%	81.25%	100%

In our analysis of MRI and ultrasound for breast pathologies, both showed 100% sensitivity, effectively detecting all cases. However, MRI had better specificity (78.57% vs. 38.46%), reducing false positives. MRI's positive predictive value (81.25%) surpassed that of lities had perfect negative predictive values, ensuring reliable exclusion of pathologies. MRI's superior specificity and predictive value enhance its role in accurate diagnosis and characterization of breast lesions, while ultrasound remains a valuable complementary tool.

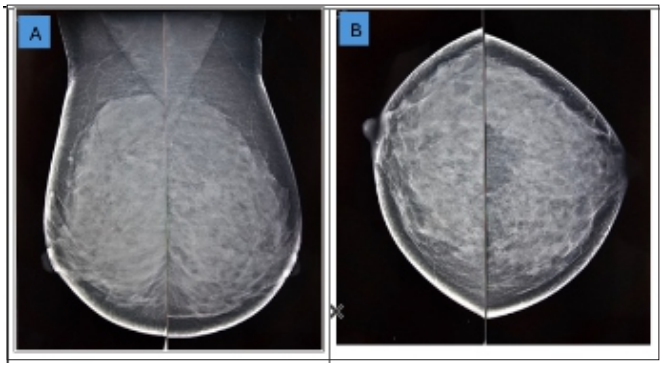
Table 5: Comparative Analysis of Histopathology and Sono Mammography Findings

Histopathology	Sonomammography	
	Benign	Malignant
Benign	5	8
Malignant	0	13

Table 6: Comparative Analysis of Histopathology and MRI Findings

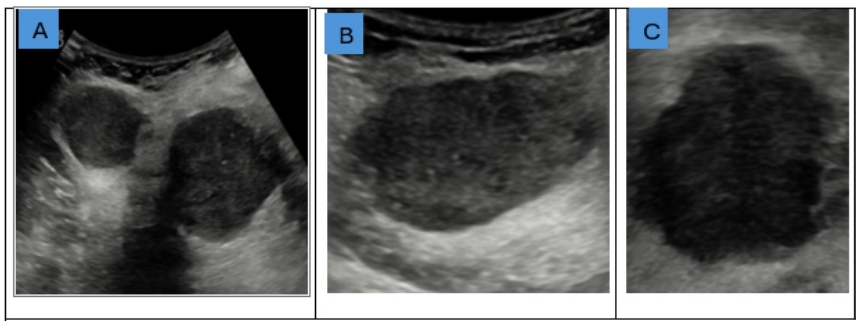
Histopathology	MRI Benign	MRI Malignant
Benign	11	3
Malignant	0	13

MRI accurately identified 11 benign cases but misclassified 3 benign cases as malignant, indicating a risk of false positives. However, it successfully detected all 13 malignant cases without any false negatives. This highlights MRI's high sensitivity and reliability in diagnosing breast cancer while noting its occasional overdiagnosis of benign



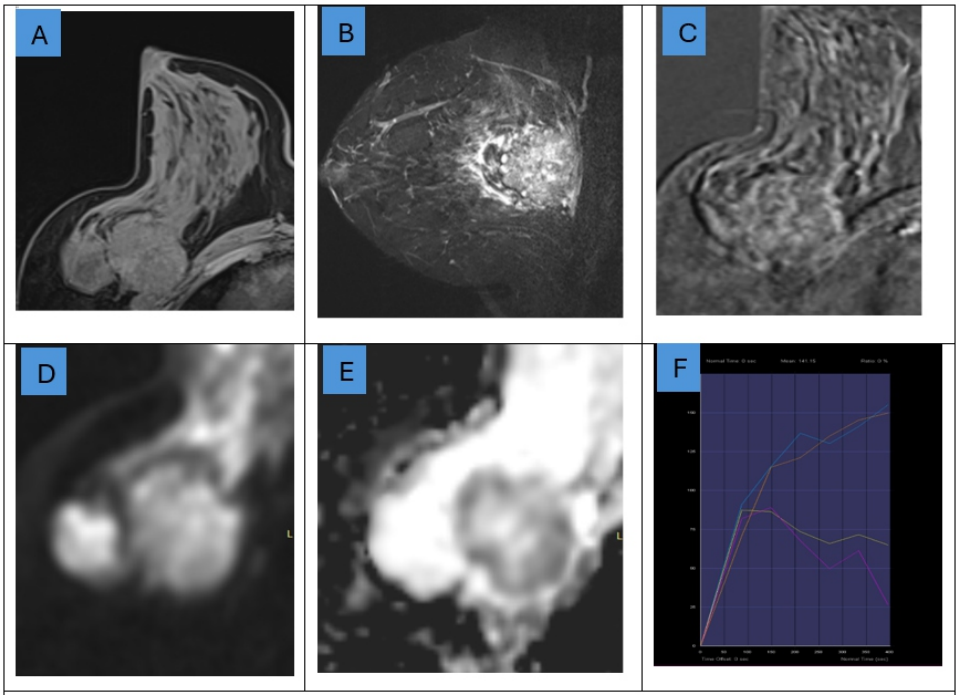
Table/Fig 7A,B

- On mammographic examination, Bilateral breast shows Type D (extreme dense breast tissue).
- However, we can see a partially circumscribed oval shaped, high-density lesion in upper outer quadrant of right breast with surrounding halo.
- No evidence of architectural distortion, asymmetry, nipple or skin involvement.
- No evidence of axillary lymphadenopathy.



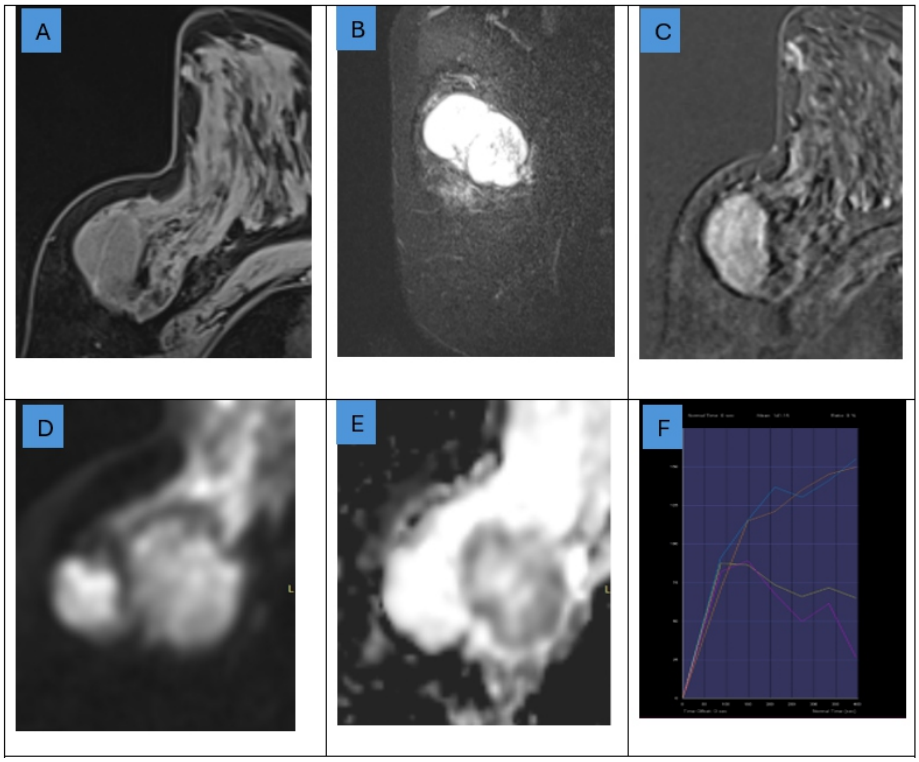
Table/Fig 8A-C

- In ultrasound we can see, two separate circumscribed round and oval shaped hypoechoic lesion, with internal vascularity, parallel orientation and posterior enhanc ement in lesion.
- No evidence of axillary lymphadenopathy.
- No evidence of architectural distortion/skin changes.
- So final BIRADS IVC and IVA was given.



On T1W fat suppressed images (Image A) right breast shows round shaped intermediate signal intensity lesion seen involving right breast which is seen to abut underlying right pectoralis muscle with loss of fat plane.

On T2W fat suppressed images (Image B) lesion appears intermediate signal intensity with surrounding perilesional oedema. On diffusion weighted images lesion is shows hyperintensity in at B800 value with signal drop in ADC map (Image D & E); suggestive of lesion is showing restriction diffusion.On post contrast subtraction images(Image C) it shows heterogeneous enhancement within.On delayed images in time-intensity curve (Pink and Yellow coloured) it show Type 3 (washout) kinetics from peripheral enhancing parts(Image F). So from above findings it suggest it neoplastic aetiology. So BIRADS 5 was assign to this lesion.



Table/Fig 10A

- T1W-Fat suppressed images (Image A) shows round shaped, circumscribed lesion involving upper outer quadrant to right breast.
- No evidence of skin thickening , other similar lesions seen.
- On, T2W,fat supressed image (Image B) show lesion appears hyperintense with no perilesional edema.
- On diffusion weighted images lesion is shows hyper intensity in at B800 value with high signal intensity in ADC map (Image D & E); suggestive of lesion is not showing restriction diffusion.On ,Post contrast subtr acted image (Image C) shows homogeneous enha - ncement.
- On calculating time-intensity curve- it shows (Type I) persistent kinetics (Image F).(Blue and orange line) So , on MRI breast examination of this lesion shows benign features , so BIRADS 3 was assigned to lesion.
- On histopathological examination:
- Ductal carcinoma in situ with single nodule of fibro - adenoma was given.

DISCUSSION

The study "Assessing the Impact of Breast MRI on BI-RADS 3 and 4 Sono Mammography Lesions" evaluated the effectiveness of breast MRI in clarifying BI-RADS 3 and 4 lesions, comparing it with mammography and ultrasound. The primary goals included assessing how MRI enhances classification of indeterminate lesions, determining its sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV), and analyzing its effect on reducing unnecessary biopsies [13]. Comprehensive data collection encompassed patient demographics, imaging characteristics, and clinical history. Our study's mean patient age was 42 ± 12 years, consistent with findings from other studies, highlighting the relevance of our results [14].

In our study comparing BI-RADS scores from Sono mammography with histopathology findings, we noted an increasing trend of malignancy with higher BI-RADS scores [15]. For lesions classified as BI-RADS IV A, B, and C, 4, 2, and 6 cases were malignant, respectively. Conversely, BI-RADS III lesions, typically deemed "probably benign," mainly consisted of inflammatory lesions, showing no malignancies[16]. These results are consistent with Hanan Mohammed Eisa et al., who found that out of 14 BI-RADS 3 lesions, 9 were benign and 5 were malignant[17]. The study highlights the predictive reliability of BI-RADS categ orization, especially for higher categories, emphasizing its importance in clinical management. BI-RADS catego rizations, among 10 BI-RADS III lesions, 5 were benign, 4 inflammatory, and 1 infective, with no malignancies detected. For BI-RADS IV, 2 out of 3 lesions were benign and 1 malignant. Notably, in BI-RADS V, 12 out of 13 lesions were malignant, indicating a high predictive value for malignancy. MRI effectively identified benign and infla mmatory conditions in BI-RADS III, helping to reassure and reduce unnecessary interventions. Additionally, both MRI and ultrasound (USG) showed 100% sensitivity, but MRI excelled in specificity (78.57% vs. 38.46%), positive predi - ctive value (81.25% vs. 61.90%), and negative predictive value, confirming its superior diagnostic accuracy [18].Our study highlights the critical role of MRI in accurately diagnosing breast cancer, particularly for BI-RADS III and IV lesions, where precise assessment is vital for clinical decision-making. MRI outperformed ultrasound(US) and mammography, demonstrating high sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). While US correctly iden tified 5 benign cases, it misclassified 8 benign lesions as malignant, revealing a significant potential for false positives [19]. Despite effectively detecting all 13 malignant cases, ultra sound struggles to differentiate benign from malignant conditions, underscoring the necessity of histopathological confirmation to avoid unnecessary anxiety and interventions for patients [20].In our study, ultrasound characteristics revealed significant insights regarding breast lesions. Round-shaped lesions, typically benign, were often associated with malignancy, while oval-shaped lesions indicated a higher likelihood of malignancy, although they also appeared in benign cases[21][22]. Irregular shapes were predominantly linked to malignant lesions. Circumscribed margins were seen in both benign and malignant cases, making them less reliable, whereas non-circumscribed margins were more frequently associated with malignancy [23][24]. Notably, heterogeneous echopatterns strongly indicated malignancy, emphasizing the need for a comprehensive diagnostic approach that correlates ultrasound findings with histo pathology for accurate assessment and management of breast lesions[25].

CONCLUSION

The study "Assessing the Impact of Breast MRI on BI-RADS 3 and 4 Sono Mammography Lesions" evaluated the effectiveness of MRI in diagnosing and characterizing indeterminate breast lesions. It demonstrated that MRI significantly improves diagnostic accuracy for BI-RADS 3 and 4 lesions compared to other imaging methods. MRI showed enhanced sensitivity, specificity, and predictive values, allowing better distinction between benign and malignant cases. Correlation with histopathology confirmed MRI's utility in refining BI-RADS categorization. The study highlights MRI as an essential tool for evaluating indeterminate lesions, with potential for further validation through multi-center studi

REFRENCES

1. Uribe-Granados GS, Galaviz-Romero E, Rios-Vidaca IL, Lazalde B. Mechanisms of Drug Resistance in Breast Cancer. GSC Biological and Pharmaceutical Sciences. 2024;27(3):105-11.
2. Bray F, Jemal A, Grey N, Ferlay J, Forman D. Global

cancer transitions according to the Human Development Index (2008–2030): a population-based study. The lancet oncology. 2012 Aug 1;13(8):790-801.

3. Mehrotra R, Yadav K. Breast cancer in India: Present scenario and the challenges ahead. World Journal of Clinical Oncology. 2022 Mar 3;13 (3):209.
4. Hasani WS, Muhamad NA, Hanis TM, Maamor NH, Chen XW, Omar MA, Cheng Kueh Y, Abd Karim Z, Hassan MR, Musa KI. The global estimate of premature cardiovascular mortality: a systematic review and meta-analysis of age-standardized mortality rate. BMC Public Health. 2023 Aug 16;23(1):1561.
5. Luo C, Li N, Lu B, Cai J, Lu M, Zhang Y, Chen H, Dai M. Global and regional trends in incidence and mortality of female breast cancer and associated factors at national level in 2000 to 2019. Chinese medical journal. 2022 Jan 5;135(01):42-51.
6. Kerlikowske K, Smith-Bindman R, Ljung BM, Grady D. Evaluation of abnormal mammography results and palpable breast abnormalities. Annals of internal medicine. 2003 Aug 19;139(4):274-84.
7. Devolli-Disha E, Manxhuka-Kërliu S, Ymeri H, Kutllovci A. Comparative accuracy of mamm ography and ultrasound in women with breast symptoms according to age and breast density. Bosnian journal of basic medical sciences. 2009 May;9(2):131.
8. Islam MM, Faruque MR, Misran N, Islam MT. Detection of breast cancer using electromagnetic techniques: A review. International Journal of Applied Electro magnetics and Mechanics. 2016 Jan 1;51(3):215-33.
9. The American College of Radiology (ACR) developed the Breast Imaging-Reporting and Data System (BI-RADS) to standardize breast lesion
10. Delorme S, Knopp MV. Non-invasive vascular imaging: assessing tumour vascularity. European radiology. 1998 May;8:517-27.
11. Eghtedari M, Chong A, Rakow-Penner R, Ojeda-Fournier H. Current status and future of BI-RADS in multimodality imaging, from the AJR special series on radiology reporting and data systems. American Journal of Roentgenology. 2021 Apr 9;216(4):860-73.
12. Hylton N. Magnetic resonance imaging of the breast: opportunities to improve breast cancer management. Journal of Clinical Oncology. 2005 Mar 10;23(8):1678-84.
13. Gielen JL, De Schepper AM, Vanhoenacker F,Parizel PM, Wang XL, Sciot R, Weyler J. Accuracy of MRI in characterization of soft tissue tumors and tumor-like lesions. A prospective study in 548 patients. European radiology. 2004 Dec;14:2320-30.
14. Fritsche LG, Igl W, Bailey JN, Grassmann F, Sengupta S, Bragg-Gresham JL, Burdon KP, Hebbring SJ, Wen C,Gorski M, Kim IK. A large genome-wide association study of age-related macular degeneration highlights contributions of rare and common variants. Nature genetics. 2016 Feb;48(2):134-43.
15. Rasheed U, Ameer S, Bukhari RS. Accuracy of Ultrasound based BI-RADS Scoring System to Predict Malignancy in Patients with Breast Lump. Pakistan Journal of Medical & Health Sciences. 2022 Jul 2;16(05):797-.
16. Corbex M, Burton R, Sancho-Garnier H. Breast cancer early detection methods for low and middle income countries, a review of the evidence. Breast [Internet]. 2012;21(4):428–34. Available from: http://dx.doi .org/10 .1016/j.breast.2012.01.002
17. Kruger G, Skin lesions on mammogram. Case study, Radiopaedia.org (Accessed on 31 Aug 2024) https://doi .org/10.53347/rID-21488
18. Mammography [Internet]. National Institute of Biome dical Imaging and Bioengineering. [cited 2024 Aug 31]. Available from: https:// www.nibib .nih.gov/ science-education/science-topics/mam-mography
19. Guo R, Lu G, Qin B, Fei B. Ultrasound Imaging Technologies for Breast Cancer Detection and Mana gement: A Review. Ultrasound Med Biol. 2018 Jan;44 (1):37-70. doi: 10.1016/j .ultrasm edbio.2017 .09.012. Epub 2017 Oct 26. PMID: 29107353; PMCID: PMC6169997.
20. Abdulloh A, Ni'mah AQ. BI-RADS classification for breast ultrasound: A review. Pharmacology, Medical Reports, Orthopedic, and Illness Details (COMORBID). 2023;2(2):67. Available from:
21. Chen M, Zhan WW, Wang WP. Cystic breast lesions by conventional ultrasonography: Sonographic subtype-pathologic correlation and BI-RADS asses sment. Arch Med Sci.2014 Feb;10(1):76-83. doi:10. 5114/aoms .2014. 40734.
22. Lee J. Practical and illustrated summary of updated BI-RADS for ultrasonography.Ultrasonography. 2017 Jan;36(1)71-81.
23. D'Orsi CJ, Sickles EA, Mendelson EB, Morris EA. ACR BI-RADS atlas, breast imaging reporting and data system.Reston,VA: American College of Radiology, 2013.
24. Lehman CD, Schnall MD. Imaging in breast cancer: magnetic resonance imaging. Breast Cancer Res. 2005;7(5):215-9. doi: 10.1186/bcr1309. Epub 2005 Aug 5. PMID: 16168141; PMCID: PMC1242161.
25. Macchia RJ, Termine JE, Buchen CD. Raymond V. Damadian, M.D.: magnetic resonance imaging and the controversy of the 2003 Nobel Prize in Physiology or Medicine. J Urol. 2007 Sep;178(3 Pt 1):783-5. doi: 10.1016/j.juro.2007.05.019. Epub 2007 Jul 16. PMID: 17631325.

How to cite: Vedantkumar K. Kapadia, Bhautik Kapadia, D Kunal Vadwala, Mehal Kamaliya. Impact of Breast MRI on BI-RADS 3 and 4 Sono-Mammography Lesions. *International Medicine,* 2024; 10 (2) :1-7