ISSN No:-2456-2165

BIRADS Lexicon and its Histopathological Corroboration in the Diagnosis of Breast Lesions

A SAI THANMAYE,
UNDERGRADUATE
VYDEHI INSTITUTE OF MEDICAL SCIENCES AND RESEARCH CENTRE,
82 NALLURAHALLI, WHITEFIELD, BENGALURU, KARNATAKA, INDIA, PIN 560066

DR. SHUBHAM GUPTA,
POST-GRADUATE RESIDENT
DEPARTMENT OF RADIODIAGNOSTICS
VYDEHI INSTITUE OF MEDICAL SCIENCES AND RESEARCH CENTRE,
82 NALLURAHALLI, WHITEFIELD, BENGALURU, KARNATAKA, INDIA, PIN 560066

DR. SALMAN KHURSHID SHAH,
POST-GRADUATE RESIDENT
DEPARTMENT OF RADIATION ONCOLOGY
VYDEHI INSTITUE OF MEDICAL SCIENCES AND RESEARCH CENTRE,
82 NALLURAHALLI, WHITEFIELD, BENGALURU, KARNATAKA, INDIA, PIN 560066

ABHINAVA S,
UNDERGRADUATE
VYDEHI INSTITUE OF MEDICAL SCIENCES AND RESEARCH CENTRE,
82 NALLURAHALLI, WHITEFIELD, BENGALURU, KARNATAKA, INDIA, PIN 560066

DR. GAYATHRI T,
ASSOCIATE PROFESSOR
DEPARTMENT OF PATHOLOGY
VYDEHI INSTITUTE OF MEDICAL SCIENCES AND RESEARCH CENTRE,
82 NALLURAHALLI, WHITEFIELD, BENGALURU, KARNATAKA, INDIA, PIN 560066

Abstract:
Background: Of all the malignancies to exist, breast cancer is and continues to be one of the most pervasive cancers. For the first time, female breast cancer was the most commonly diagnosed cancer surpassing lung cancer as reported by the American Cancer Society (ACS) and the International Agency for Research on Cancer (IARC) of 2020. Breast cancer is considered to be a heterogeneous disease due to its presentation of a wide variety of morphological, histopathological and biological features. Aim of the Study: To analyse the concordance of ultrasound findings of BI-RADS categories 2, 3, 4 and 5 lesions with histopathological biopsy results and calculate the predictive value and diagnostic accuracy of BIRADS. Materials and methods: It isa retrospective study, data were collected over a period of 5 years, from 2016 to 2020. Data from a total of 190 patients with related symptomatology and breast lumps who underwent ultrasound examination by expert radiologists were collected. The data were also correlated with pathological findings for those patients who underwent biopsy, the two were correlated. Results: BIRADS Lexicon had a high sensitivity of 95.23%, and the specificity and diagnostic accuracy were calculated to be 92.78% and 94.89% each respectively. BIRADS 2&3 had a high NPV of 97.82% and 4 and 5 had a PPV of 85.10%. The fact that there is a relatively high NPV for the lower BIRADS categories can be exploited and biopsies can be largely avoided in these cases. The high sensitivity of the BIRADS lexicon makes ultrasound a close alternative for mammography in the preliminary screening of breast lesions.

I. INTRODUCTION

Breast cancer is the most common cancer, accounting for 23% of the total cancers and 14% of the cancer deaths in females in 2020[1]. Various studies have proclaimed that early diagnosis of breast cancers can reduce mortality and improve prognosis.[2]Various methods are used for the diagnosis of breast lesions; mammography, ultrasonography, electrical-based impedance imaging, CT scan, MRI etc.[3]Mammography is the primary gold standard among the available screening methods[4]. Ultrasound has proven to be a close adjunct, being more economical, more versatile and portable and hence, an ideal method for palpable lesions.[5]Ultrasound can be used to discern between solid and cystic lesions, and the solid lesions that suggest an abnormality can be further evaluated by a biopsy, making it an ideal choice of a screening method for those who require biopsy. Ultrasound is particularly preferred in cases of dense breast tissue that may be ambiguous on a mammogram. B mode ultrasonography is most commonly employed. Ultrasonic waves are emitted perpendicular to the transducer's surface. The echoes from the long axis along with various tissues that are echoed are picked up by the

ISSN No:-2456-2165

transducer to reconstruct a two-dimensional image of the breast. Intraparenchymal fatty tissue appears hypoechogenic, normal fatty tissue and breast parenchyma appear hyperechogenic.Doppler ultrasound can be performed to detect the vascularity of the lesion.[6]The breast lesions, radiologically are classified by a standardised system called the BI-RADS; breast imaging reporting and a data system which can be applied to mammograms, ultrasound and MRI. The breast imaging reporting and data system (BI-RADS) was established in 1993 and promulgated by the American College of Radiology (ACR) to standardise the reporting of radiological findings, and enable communication between clinicians[7]. There are 6 categories in the classification which represent the possibility of the occurrence of breast tumours in their increasing order.

II. AIM OF THE STUDY

To analyse the concordance of ultrasound findings of BI-RADS categories 2, 3, 4 and 5 lesions with histopathological biopsy results and to calculate the predictive value and diagnostic accuracy of BIRADS.

III. MATERIALS AND METHODS

This was a non-randomised retrospective study conducted over a period of 5 years from 2016 to 2020 in the departments of Radiodiagnostics and Pathology at Vydehi Institute of Medical Sciences and Research centre, Bangalore. Patients alluded to the radiology department underwent an ultrasound of the breast performed using a machine by expert radiologists who had a minimum experience of 4 to 6 years. Ultrasound scan was performed using a Linear Array Transducer of L12-4 MHz and real time images of the breast and its lesions were acquired in craniocaudal and transverse views.The breast ultrasonogram was analysed for several features like margins, calcifications, cysts, shape, echogenicity, and accompanying features like architectural contortion, duct changes, skin thickening, skin retraction, oedema and vascularity accordingly, they were classified into various BIRADS categories. A core biopsy of the breast region was performed for suspicious cases and analysed under a compound microscope by an expert pathologist and visualised. Its results were classified and compared with the BIRADS score.

A. *Inclusion criteria:*

- Patients who have presented with complaints of lump in the breast, pain, nipple discharge or retraction.
- Patients who have undergone breast ultrasound with results classified into their respective BIRADS categories.
- Patients who have undergone trucut biopsy.

B. *Exclusion criteria:*

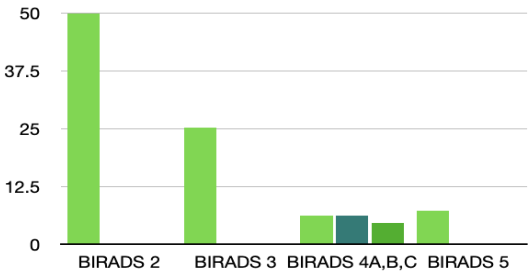
- Patients who have undergone radiological ultrasound, but have not undergone biopsy.
- Patients are classified as BI-RADS category 1 which indicates the absence of a breast lesion.
- Patients who have undergone biopsy but have not undergone ultrasound.

IV. PROCEDURE

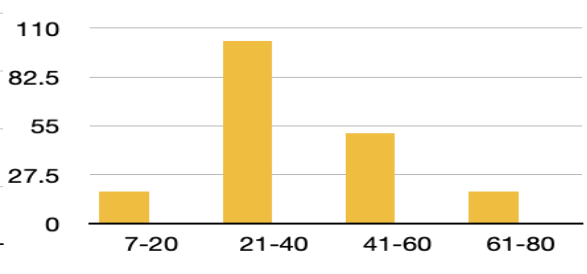
A retrospective study was conducted in a tertiary health care centre in the city of Bangalore for a period of 5 years from 2016 to 2020 with patients who have undergone radiological examination of the breast as per recommendations from medicine, surgical, oncology or other departments after the suggestive clinical presentation of associated symptoms. Out of these patients, those with BI-RADS categories 2,3,4 and 5 and sent for core biopsy, were further studied. Their histopathological biopsy results was correlated to their breast ultrasound results. All the observations were analysed by an expert radiologist.

V. RESULTS

All our patients belonged to the Asian ethnicity. Data from a total of 190 patients were collected of which, 186 were females and 4 were males. Most of the cases were between 21 to 40(54.21%)years of age, followed by 41-60 years(26.84%), 61 to 80 years(9.47%) and 7-20 years of age(9.47%). Bar graph 1, depicts the age-wise distribution of the sample. Radiological evaluation through ultrasound demonstrated that most of the lesions belonged to BIRADS 2(50%), followed by BIRADS 3(25.26%), BIRADS 5(7.36%), BIRADS 4A (6.31%)= 4B(6.31%) and BIRADS 4C(4.73%). The frequency of various BIRADS categories is depicted in Bar graph 2.



Bar graph 2: Radiological distribution of cases (in %)



Bar graph 1: Age wise distribution of cases

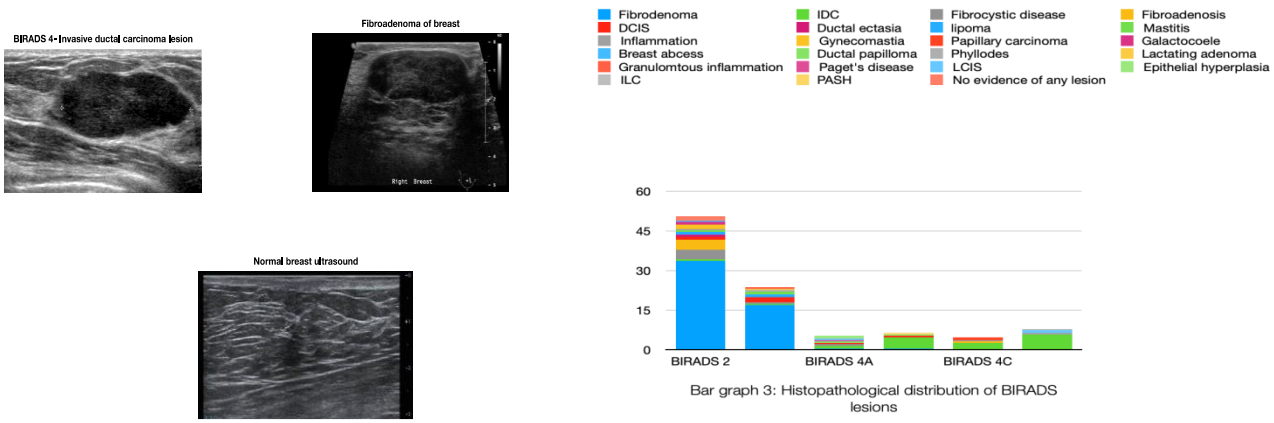
Fig. 1

ISSN No:-2456-2165

Histopathological examinations revealed that the most common lesion is the Fibroadenoma accounting for 101 cases (53.15%) of the 190 cases. This was followed by invasive ductal carcinoma accounting for 28 cases (14.73%). Other lesions include fibrocystic disease, lipoma, ductal ectasia, gynecomastia, Ductal carcinoma in situ, etc. Lesion wise distribution according to their respective BIRADS categories is depicted in Table 1.

	BIRADS 2	BIRADS 3	BIRADS 4A	BIRADS 4B	BIRADS 4C	BIRADS 5	Total	Percentage
Fibroadenoma	64	35	1	1	0	0	101	53.15%
Invasive ductal carcinoma	1	1	2	8	5	11	28	14.73%
Fibrocystic sisease	7	1	1	0	0	0	9	4.73%
Fibroadenosis	7	0	0	0	0	0	7	3.68%
DCIS	0	4	1	1	1	0	7	3.68%
Ductal ectasia	2	0	2	0	0	0	4	2.10%
Lipoma	2	2	0	0	0	0	4	2.10%
Mastitis	1	2	0	0	0	0	3	1.57%
Inflammation	1	0	0	0	1	1	3	1.57%
Gynecomastia	3	0	0	0	0	0	3	1.57%
Papillary carcinoma	0	0	0	0	2	0	2	1.05%
Galactocoele	2	0	0	0	0	0	2	1.05%
Sebaceous cyst	1	0	0	0	0	0	1	0.52%
Breast abcess	1	0	0	0	0	0	1	0.52%
Ductal papilloma	0	0	1	1	0	0	2	1.05%
Phyllodes	0	1	0	0	0	0	1	0.52%
Lactating adenoma	0	1	0	0	0	0	1	0.52%
Granulomatous inflammation	0	1	0	0	0	0	1	0.52%
Paget's disease	0	0	1	0	0	0	1	0.52%
LCIS	0	0	1	0	0	2	3	1.57%
Epithelial hyperplasia	0	0	2	0	0	0	2	1.05%
ILC	0	0	0	0	0	1	1	0.52%
PASH	0	0	0	1	0	0	1	0.52%
No evidence of any lesion	3	0	0	0	0	0	3	1.57%
TOTAL	95	48	12	12	9	14	190	
Percentage	50%	25.26%	6.31%	6.31%	4.73%	7.36%		

Table 1: Radiological and Histopathological distribution of BIRADS score and Biopsy results



Bar graph 3: Histopathological distribution of BIRADS lesions

Fig. 2

ISSN No:-2456-2165

Most of the cases of BIRADS 2 were benign, Fibroadenoma being the most common, 64/110 cases-58.18%. This was followed by Fibrocystic disease and Fibroadenosis, 7 cases each respectively. There were 3 cases of Gynecomastia, 2 cases of each, Ductal ectasia, Galactcoele, and Lipoma. 1 case of Mastitis, Inflammation, Breast abscess, Sebaceous cyst, and Invasive ductal carcinoma respectively. The total number of benign cases in BIRADS 2 was 90(94.73%), malignant 2(2.10%) and 3 cases had no evidence of any malignancy (3.15%).

The majority of cases in BIRADS 3 were a Fibroadenoma, 35 cases (72.91%), followed by 4 cases of Ductal Carcinoma In Situ, 2 cases each of Lipoma, Mastitis, 1 case of Phyllodes, Lactating adenoma and Granulomatous inflammation respectively. Most of the cases were benign 42(87.5%), and 6 cases were malignant(12.5%).

BIRADS 4A had a total of 12 cases of which, there were 2 cases of Invasive ductal carcinoma, Epithelial hyperplasia, and Ductal ectasia. 1 case of Fibroadenoma, Fibrocystic disease, Ductal papilloma, Ductal Carcinoma In Situ, Paget's disease and Lobular Carcinoma In Situ. 42% of the cases were benign and 52% of the cases were malignant.

Out of the 12 cases of BIRADS 4B, there were 8 cases of Invasive Ductal Carcinoma, 1 case of Ductal Carcinoma In Situ, and 1 case of PASH and Ductal papilloma. 2(16.67%) of the cases were benign and 10(83.3%) of the cases are malignant.

There were 9 cases of BIRADS 4C; 5 Invasive Ductal Carcinoma, 1 of Ductal Carcinoma In Situ, Inflammation, and 2 of Papillary carcinoma. 100% of the cases were malignant.

Of the 14 cases of BIRADS 5, 11 were Invasive Ductal Carcinoma, 1 of Inflammation 2 of Lobular Carcinoma In Situ and 1 of Invasive Lobular Carcinoma. 100% of the cases were malignant.

The benign vs malignant distribution of cases is depicted in Table 2. Histopathological distribution according to the BIRADS score is illustrated in bar graph 3.

BIRADS	Benign	Malignant	No evidence of any lesion	Total
2	90(94.73%)	2(2.10%)	3(3.15%)	95
3	42(87.5%)	6(12.5%)	0(0%)	48
4A	5(0.41%)	7(0.58%)	0(0%)	12
4B	2(16.66%)	10(83.33%)	0(0%)	12
4C	0(0%)	9(100%)	0(0%)	9
5	0(0%)	14(100%)	0(0%)	14

Table 2: Benign Vs Malignant distribution of cases

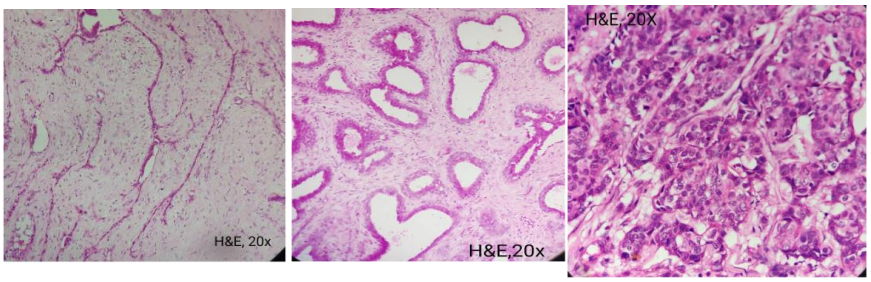
The negative predictive value for BIRADS 2&3 was calculated to be 97.82%.

The positive predictive value for BIRADS 4&5 is 85.10%.

Sensitivity, specificity and diagnostic accuracy are 95.23%, 92.78%, and 94.89%respectively.

Sonographic feature	NPV	Sonographic feature	PPV
Wider than taller	94.20%	Taller than wider	95.74%
Calcifications	92.02%	Microcalcifications	89.36%
Parallel to long axis	92.64%	Not parallel to long axis	87.75%
Regular margins	92.53%	Irregular margins	84.89%

Table 3: PPV and NPV of various sonographic features



Pericanalicular pattern of fibroadenoma under 20X magnification

Intracanalicular pattern of Fibroadenoma under 20X magnification

Invasive ductal carcinoma under 20X magnification

Fig. 3

ISSN No:-2456-2165

VI. DISCUSSION

Breast cancer is a common malignancy in India. Lack of adequate knowledge related to self-examination of the condition has led to the detection of the lesion in the late stages which is usually associated with a poorer prognosis. There has been a lot of deliberation on the use of ultrasound as a primary modality in the screening of breast lesions in the recent past.[8-11]The BIRADS lexicon has been a useful tool for the systematic categorisation of breast lesions. Although some amount of inter-observer variability is expected, various studies agree substantially on the category of BIRADS without many gross differences.[12-13]A comprehensive review of recent literature has demonstrated that the usage of US as an adjunct to mammogram has yielded higher sensitivity.[14]Several studies have also shown that ultrasound is particularly useful compared to mammogram in dense breasts and women of older age groups.[15-17]Our study found the sensitivity of BIRADS US to be, which is similar to other studies conducted by *Hille*, *Starvos*and *Heinig*.[18-20] Our study puts forward ultrasound as an effective subsistence for primary screening of breast lesions. However, contradictory results have been elicited in other studies that show ultrasound has low sensitivity. These studies recommend biopsies extensively[21,22]. However, we feel that BIRADS categorisation, on the whole, is determined by the experience of the radiologist and the technology used.

Most of the benign lesions were hypoechoic wider than taller and did not have calcifications or irregular borders. In contrast, most of the malignant lesions had irregular borders and were taller rather than wider and hypoechoic, these findings are consistent with other studies like *Hong* and *Costantini*that have calculated PPV and NPV for each of the US parameters[23,24].

Our study has a high NPV for BIRADS 2 & 3 and high PPV for BIRADS 4 and 5, which are analogous to the results of a few publications. This suggests that biopsies can be avoided for benign cases in ultrasound and are highly recommended for BIRADS 4 and above. Therefore, ultrasound can be an effective alternative to mammography for preliminary screening of breast lesions for lower age groups, below 40 years.

REFERENCES

[1.] Sung H, Ferlay J, Siegel R, Laversanne M, Soerjomataram I, Jemal A et al. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA: A Cancer Journal for Clinicians. 2021;71(3):209-249.

[2.] Smith RA, Caleffi M, Albert US, Chen TH, Duffy SW, Franceschi D, Nyström L, Global Summit Early Detection and Access to Care Panel. Breast cancer in limited-resource countries: early detection and access to care. The breast journal. 2006 Jan;12:S16-26.

[3.] Shiovitz S, Korde L. Genetics of breast cancer: a topic in evolution. Annals of Oncology. 2015;26(7):1291-1299.

[4.] Blamey RW, Wilson AR, Patnick J. Screening for breast cancer. Bmj. 2000 Sep 16;321(7262):689-93.

[5.] Devolli-Disha E, Manxhuka-Kërliu S, Ymeri H, Kutllovci A. Comparative Accuracy of Mammography and Ultrasound in Women with Breast Symptoms According to Age and Breast Density. Bosnian Journal of Basic Medical Sciences. 2009;9(2):131-136.

[6.] Athanasiou A, Tardivon A, Ollivier L, Thibault F, El Khoury C, Neuenschwander S. How to optimize breast ultrasound. European journal of radiology. 2009 Jan 1;69(1):6-13.

[7.] American College of Radiology. The ACR breast imaging reporting and data system (BI-RADS) [web source]. November 11, 2003. Available from: http://www.acr.org/departments/stand_accred/birads/ contents.html. Accessed February, 27, 2004.

[8.] Kopans DB. Effectiveness of US breast cancer screening remains to be demonstrated (letter). Radiology 2003; 227: 606 [illegible]9. Gordon PB. Ultrasound for breast cancer screening and staging. RadiolClin North Am 2002; 40: 403–441 [illegible]10. Nothacker M, Duda V, Hahn M et al. Early detection12 of breast cancer: benefits and risks of supplemental breast ultrasound in asymptomatic women with mammographically dense breast tissue. A systematic re-view. BMC cancer 2009; 9: 335 [illegible]11. Ohta T, Okamotot K, Kanemaki Y et al. Use of ultrasonography as an al- ternative modality for first-line examination in detecting breast cancer in selected patients. Clin Breast Cancer 2007; 7: 624–626 [illegible]12. Calas M, Almeida R, Gutfilen B, Pereira W. Intraobserver interpretation of breast ultrasonography following the BI-RADS classification. European Journal of Radiology. 2010;74(3):525-528.

[9.] Lee H, Kim E, Kim M, Youk J, Lee J, Kang D et al. Observer variability of Breast Imaging Reporting and Data System (BI-RADS) for breast ultrasound. European Journal of Radiology. 2008;65(2):293-298.

[10.] McCavert M, O'Donnell M, Aroori S, Badger S, Sharif M, Crothers J et al. Ultrasound is a useful adjunct to mammography in the assessment of breast tumours in all patients. International Journal of Clinical Practice. 2009;63(11):1589-1594.

[11.] Thigpen D, Kappler A, Brem R. The Role of Ultrasound in Screening Dense Breasts—A Review of the Literature and Practical Solutions for Implementation. Diagnostics. 2018;8(1):20.

[12.] Bae MS, Moon WK, Chang JM, Koo HR, Kim WH, Cho N, Yi A, La Yun B, Lee SH, Kim MY, Rye EB. Breast cancer detected with screening US: reasons for nondetection at mammography. Radiology. 2014 Feb;270(2):369-77.

[13.] Kim S, Kim H, Moon W. Automated Breast Ultrasound Screening for Dense Breasts. Korean Journal of Radiology. 2020;21(1):15.

[14.] Hille H, Vetter M, Hackelöer B. The Accuracy of BI-RADS Classification of Breast Ultrasound as a First-Line Imaging Method. Ultraschall in der Medizin - European Journal of Ultrasound. 2011;33(02):160-163.

[15.] Stavros T, Thickman D, Rapp CL, Dennis MA, Parker SH, SisneyGA. Solid breast nodules: use of

ISSN No:-2456-2165

sonography to distinguish between benign and malignant lesions. Radiology 1995; 196: 123–134.

[16.] Heinig J, Witteler R, Schmitz R, Kiesel L, Steinhard J. Accuracy of classification of breast ultrasound findings based on criteria used for BI-RADS. Ultrasound in Obstetrics and Gynecology. 2008;32(4):573-578.

[17.] Corsetti V, Houssami N, Ferrari A et al. Breast screening with ultrasound in women with mammography-negative dense breasts: Evidence on incremental cancer detection and false positives, and associated cost. Eur J Cancer 2008; 44: 539–544 22. Berg WA, Blume JD, Cormack JB et al. Combined screening with ultra-sound and mammography vs. mammography alone in women at ele- vated risk of breast cancer. JAMA 2008; 299: 2151–2163 23. 10. Hong A, Rosen E, Soo M, Baker J. BI-RADS for Sonography: Positive and Negative Predictive Values of Sonographic Features. American Journal of Roentgenology. 2005;184(4):1260-1265.

[18.] Costantini M, Belli P, Lombardi R, Franceschini G, Mulè A, Bonomo L. Characterization of solid breast masses: use of the sonographic breast imaging reporting and data system lexicon. Journal of ultrasound in medicine. 2006 May;25(5):649-59.

ISSN No:-2456-2165

ETHICAL COMPLIANCE

Funding: No funding is required for the study.

Conflict of interest: There was no conflict of interest while conducting the study.

Ethical approval: All procedures conducted in the study involving human participants were following the ethical standards of the institutional and /or national research committee.
Informed consent: Not required as it was a retrospective study.

Contributions from authors:
A Sai Thanmaye (AS)
Dr Shubham Gupta (SG)
Dr Salman Khurshid Shah (SK)
Abhinava S (AS)
Dr Gayathri T (GT)

Major contributions to the design of the work; or the acquisition, analysis, or interpretation of work data- (AS, SG, SK, AS, GT)
The final version to be published was approved by (AS, SG, SK, AS and GT)
Accountability agreement on all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are investigated and resolved appropriately-(AS, SG, SK, AS and GT)

Dear Editor,
I, **A SAI THANMAYE** (corresponding author) am submitting this paper titled **'BIRADS lexicon and its histopathological corroboration in the diagnosis of breast lesions'** in your reputed journal for publication.
There were no conflicts of interest or financial support.

Thanking you,