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Research Article

CYTO-RADIOLOGICAL CORRELATION OF BREAST LESIONS USING IAC YOKOHAMA AND BI-RADS CLASSIFICATION SYSTEMS

Dr Vishal[1], Dr Parveen Kundu[2], Dr Monika Gathwal[2], Dr Chiranjeev Gathwal[3], Dr Pushpendra Malik[4], Dr Vaishali[5*]

[1]Senior Resident, Department of Pathology, Institute of Medical Sciences, Banaras Hindu University, Varanasi.

[2]Professor, Department of Pathology, BPS GMC, Khanpur Kalan, Sonepat, Haryana

[3]Professor and Head, Department of Radiodiagnosis, BPS GMC, Khanpur Kalan, Sonepat, Haryana

[4]Professor, Department of General Surgery, BPS GMC, Khanpur Kalan, Sonepat, Haryana

[5*]Assistant Professor, Department of Pathology, SSSDBJ GMC, Jind, Haryana.

Corresponding Author- Dr Vaishali, Assistant Professor, Department of Pathology, SSSDBJ GMC, Jind, Haryana. Email ID- vvvvaishali@gmail.com

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Abstract

Background: Breast lesions require an integrated approach involving clinical, radiological, and pathological assessment. The IAC Yokohama System standardizes breast FNAC reporting, while BI-RADS provides radiological risk stratification. This study evaluated the cyto-radiological correlation between the two systems.

Materials and Methods: A hospital-based cross-sectional study was conducted from September 2022 to September 2023 at a rural tertiary-care centre. A total of 104 patients with breast lesions underwent FNAC and ultrasonographic assessment. Cytological findings were categorized according to the IAC Yokohama System and imaging findings according to ACR BI-RADS. The association between the two systems was statistically assessed. Histopathological evaluation was available in 60 cases.

Results: Yokohama classification showed 49 (47.1%) benign (C2), 28 (26.9%) atypical (C3), 8 (7.7%) insufficient (C1), 3 (2.9%) suspicious (C4), and 16 (15.4%) malignant (C5) cases. BI-RADS classification showed 42 (40.4%) category 3, 41 (39.4%) category 4, 18 (17.3%) category 2, and 3 (2.9%) category 5 lesions. All 12 BI-RADS 4C lesions were C5, while 13 of 16 C5 lesions were BI-RADS IV–V. A significant moderate positive correlation was observed between the two systems (Pearson's $r = 0.442$, $p < 0.001$).

Conclusion: The IAC Yokohama and BI-RADS systems demonstrate a significant positive correlation and provide complementary diagnostic information. Their integrated use may facilitate risk stratification and appropriate selection of breast lesions requiring further histopathological evaluation.

Keywords: Breast lesions; FNAC; IAC Yokohama System; BI-RADS; Ultrasonography; Cyto-radiological correlation.

INRODUCTION

Breast cancer is the most commonly diagnosed cancer among women worldwide and remains one of the leading causes of cancer-related mortality in females. It is a heterogeneous disease with diverse histopathological and molecular characteristics that influence prognosis and therapeutic response.[1] Despite significant advances in screening, imaging, molecular diagnostics, and targeted therapies, breast cancer continues to pose a major global

public health challenge, particularly in low- and middle-income countries where delayed diagnosis and limited access to healthcare adversely affect survival.[2]

According to the GLOBOCAN 2024 estimates, breast cancer is the most common cancer among women and the second most frequently diagnosed cancer overall, accounting for 2,434,087 new cases worldwide with an age-standardized incidence rate (ASR) of 47.8 per 100,000 population. It is also the fourth leading cause of cancer-related deaths, responsible for 693,660 deaths globally (ASR 12.9 per 100,000). Asia contributes the largest share of the global burden, accounting for 45.1% of incident cases and 48.3% of breast cancer-related deaths, highlighting the growing impact of the disease in developing countries.[3]

In India, breast cancer has emerged as the most common malignancy among women and the leading cancer overall. According to GLOBOCAN 2024, India reported 237,231 new breast cancer cases, representing 30.4% of all cancers in women and 15.2% of all cancers across both sexes. Breast cancer was also responsible for 96,100 deaths, making it the second leading cause of cancer-related mortality in the country.[4]

Despite improvements in awareness and healthcare services, many Indian women continue to present with advanced-stage disease owing to delayed diagnosis, limited access to screening programs, socioeconomic barriers, and lack of awareness.[5] Early detection through an integrated approach involving clinical examination, imaging, and pathological evaluation remains the cornerstone for improving survival and reducing mortality.[6]

The evaluation of breast lesions is based on the principle of triple assessment, comprising clinical examination, imaging, and pathological diagnosis. Ultrasonography categorized according to the Breast Imaging Reporting and Data System (BI-RADS) provides standardized radiological risk stratification, whereas fine-needle aspiration cytology (FNAC) reported using the International Academy of Cytology (IAC) Yokohama System offers a rapid, minimally invasive, and cost-effective method for diagnosis. Correlation between these standardized systems enhances diagnostic accuracy, facilitates multidisciplinary communication, and guides appropriate patient management.[6,7]

Therefore, the present study was undertaken to evaluate breast lesions using the IAC Yokohama System for Reporting Breast FNAC and to correlate the cytological findings with ultrasonography-based BI-RADS classification, thereby assessing the diagnostic correlation between these two standardized modalities.

MATERIALS AND METHODS

Study Design:

A hospital-based cross-sectional study was conducted in the Department of Pathology over a period of one year.

Study Population:

The study included 104 patients presenting with breast lesions to the Surgery Outpatient Department (OPD) who were referred to the Department of Pathology for FNAC.

Data Collection and Diagnostic Evaluation:

Consecutive sampling was done. FNAC was performed in all cases, and cytological findings were categorized according to the IAC Yokohama System for Reporting Breast FNAC. Radiological assessment was performed using the BI-RADS classification. Clinical, radiological, and cytological findings were correlated for diagnostic assessment. Overall, 60 of the 104 FNAC cases underwent histopathological evaluation.

Inclusion and Exclusion Criteria:

All patients presenting with a breast lesion who were referred to the Department of Pathology for FNAC during the study period were included. Patients with ulcerative breast lesions, skin involvement,

or a history of chemotherapy or radiotherapy were excluded.

Ethical Considerations:

Ethical approval was obtained from the Institutional Ethics Committee (IEC Registration No. BPSGMCW/RC/799/IEC/2022, dated 11 October 2022). Written informed consent was obtained from all participants after explaining the study objectives and procedures. Confidentiality and privacy of participant data were maintained, and participation was voluntary.

Statistical Analysis:

Statistical analysis was performed using Microsoft Excel. Using SPSS (version 20), a p-value < 0.05 was considered statistically significant.

RESULTS

A total of 104 patients with breast lesions underwent FNAC during the study period. On cytological categorization according to the IAC Yokohama System, 49 cases (47.1%) were classified as benign (C2), followed by 28 cases (26.9%) as atypical (C3). Eight cases (7.7%) were insufficient (C1), three (2.9%) were suspicious for malignancy (C4), and 16 (15.4%) were malignant (C5). Thus, benign lesions constituted the largest cytological group in the study.

Table 1 summarizes the ultrasound-based ACR BI-RADS distribution. BI-RADS 3 was the most frequent category, comprising 42 cases (40.4%), closely followed by BI-RADS 4 with 41 cases (39.4%). BI-RADS 2 accounted for 18 cases (17.3%), while only three cases (2.9%) were categorized as BI-RADS 5. No lesion was classified as BI-RADS 1.

Table 1: Ultrasound-based categorization of breast lesions based on ACR-BIRAD System (n=104)

ACR BI-RADS	No. of cases (n)	Percentage (%)
BI-RADS 1	0	0
BI-RADS 2	18	17.3
BI-RADS 3	42	40.4
BI-RADS 4	41	39.4
BI-RADS 5	3	2.9
Total	**104**	**100.0**

Table 2 shows Diagnostic categorization of 104 breast lesions FNAC based on Yokohama System show most of the cases belonged to Category II (47.11%) followed by Category III (26.9%).

Table 2: Diagnostic categorization by Yokohama system for reporting breast lesions (n=104)

Category	No. of cases (n)	Percentage
Insufficient	8	7.7
Benign	49	47.1
Atypical	28	26.9
Suspicious of Malignancy	3	2.9
Malignant	16	15.4
Total	104	100.0

Table 3 demonstrates the distribution of Yokohama cytological categories across the different BI-RADS categories. Among BI-RADS 2 lesions, the majority were cytologically benign (13/18), while BI-RADS 3 lesions were predominantly C2 (22/42) or C3 (10/42). The BI-RADS 4A group showed 14 C2 and 13 C3 lesions, whereas all 12 BI-RADS 4C lesions were categorized as C5. Among the three BI-RADS 5 lesions, one each was classified as C3, C4, and C5, demonstrating an overall shift toward higher Yokohama categories with increasing radiological suspicion.

Table 3. Association of the Yokohama system with the BIRAD system

BI-RADS		Yokohama					Total
		C1	C2	C3	C4	C5	
0	Incomplete	-	-	-	-	-	-
1	Negative	-	-	-	-	-	-
2	Benign	1	13	4	0	0	18
3	Probably benign	7	22	10	0	3	42
4A	Suspicious of carcinoma (Low Suspicion)	-	14	13	-		27
4B	Suspicious of carcinoma (Moderate Suspicion)	-	-	-	2	-	2

4C	Suspicious of carcinoma (High Suspicion)	-	-	-	-	12	12
5	Highly suspicious of carcinoma	-	-	1	1	1	3
Total		**8**	**49**	**28**	**3**	**16**	**104**

Table 4 presents the broad correlation between Yokohama categories and BI-RADS groups. Of the eight C1 cases, all were associated with BI-RADS I–III lesions. Among 49 C2 cases, 35 were BI-RADS I–III and 14 were BI-RADS IV–V. Of the 28 C3 cases, 14 belonged to each BI-RADS group. All three C4 cases were associated with BI-RADS IV–V, while 13 of 16 C5 cases were categorized as BI-RADS IV–V and three as BI-RADS I–III. Overall, 60 cases were classified as BI-RADS I–III and 44 as BI-RADS IV–V.

Table 4. Correlation of Yokohama category with BIRAD system (n=104)

Yokohama Category		**FNAC Cases**	**BI-RADS I, II, III**	**BI-RADS IV, V**
C1	**Insufficient**	8	8	0
C2	**Benign**	49	35	14
C3	**Atypical**	28	14	14
C4	**Suspicious of Malignancy**	3	0	3
C5	**Malignant**	16	3	13
Total		**104**	**60**	**44**

Table 5 and Figure 1demonstrate the statistical correlation between the Yokohama and BI-RADS classifications. A moderate positive correlation was observed, with a Pearson correlation coefficient of $r = 0.442$, which was statistically significant ($p < 0.001$). This indicates that higher BI-RADS categories tended to be associated with higher Yokohama cytological categories.

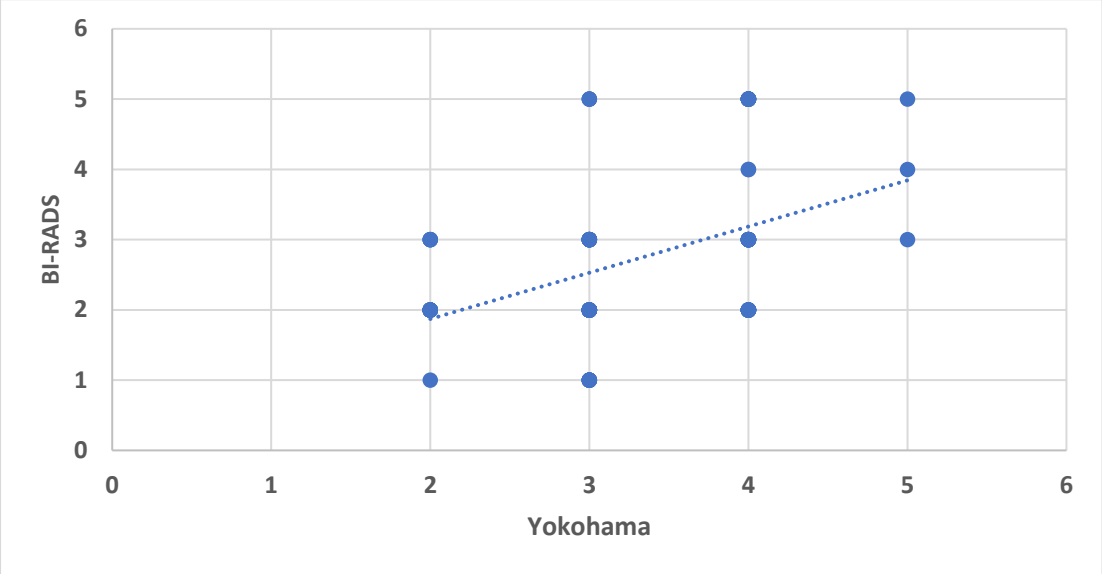
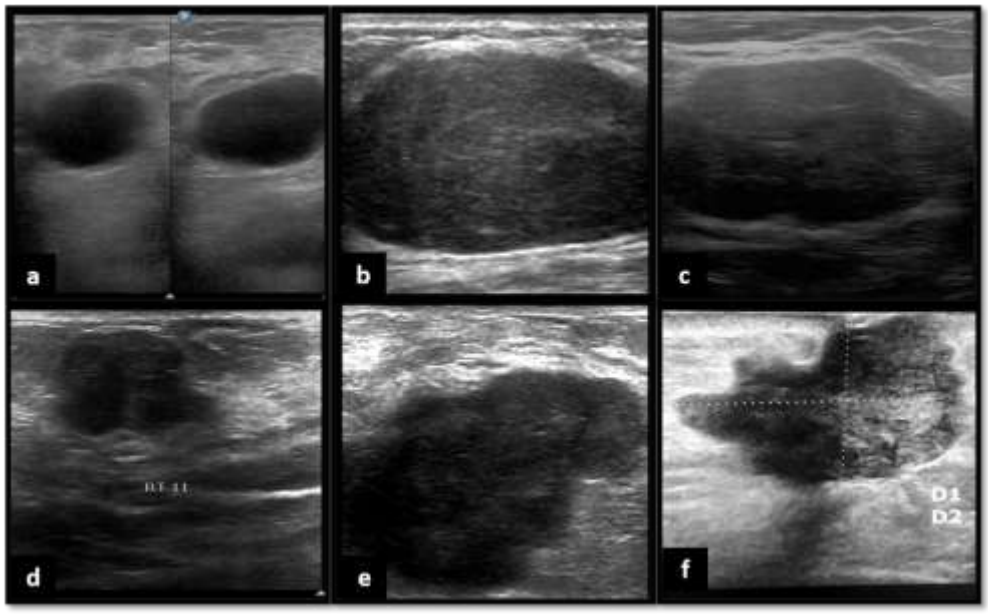


Figure 1. Correlation between Yokohama Classification and BIRAD System

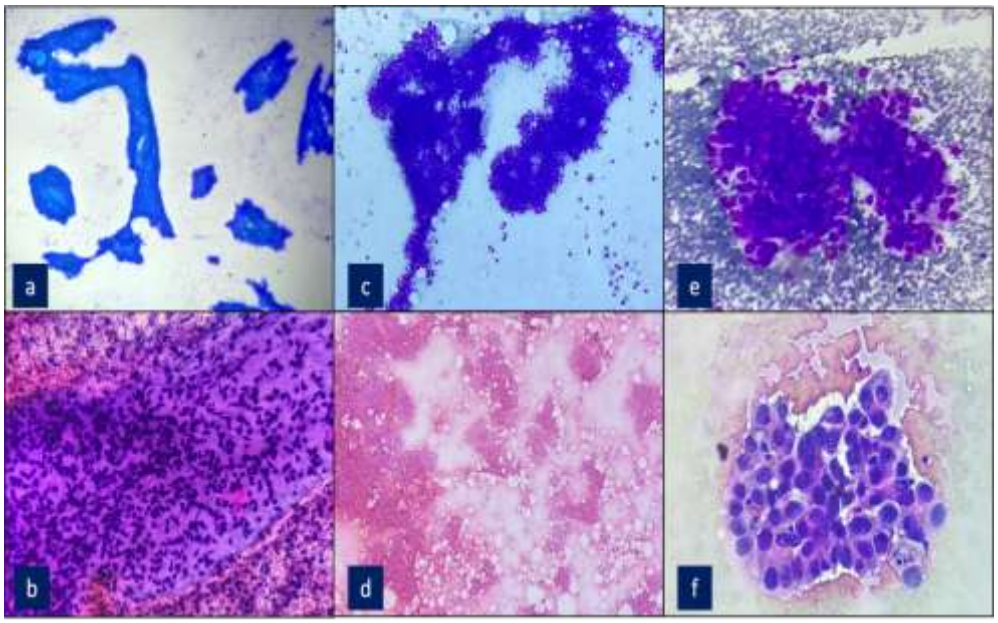
Table 5. Correlation between Yokohama Classification and BIRAD System (n=104)

		Yokohama
BI-RADS	Pearson Correlation	.442
	P-value	.000
	Total Cases	**104**

Overall, the results demonstrate a significant positive cyto-radiological relationship between the IAC Yokohama and BI-RADS classification systems, with increasing radiological suspicion generally corresponding to increasing cytological risk.



(a) BI-RADS 2, a well-defined oval anechoic lesion with well circumscribed margins, with post acoustic enhancement. **(b) BI-RADS 3**, a well-defined oval hypoechoic lesion with well circumscribed margins, with internal homogenous echogenicity. **(c) BI-RADS 4A,** a well-defined oval hypoechoic lesion with circumscribed margins and minimal lobulations. **(d) BI-RADS 4B**, an irregular, very hypoechoic lesion with ill-defined lobulated margins, AP diameter > Width. **(e) BI-RADS 4C,** an ill-defined lobulated, very hypoechoic lesion with post acoustic shadowing. **(f) BI-RADS 5,** an ill-defined very hypoechoic lesion with slight lobulations with posterior acoustic shadowing and minimal spiculations.



(a)**CategoryI**: Fibroadenoma, (b)**Category II**: Phyllodes Tumor,(c)**Category III**: Proliferative breast lesion with atypia(d)**Category IV:**Suspicious of malignancy, (e) & (f) **Category V**:Carcinoma Breast.

DISCUSSION

The present study evaluated the cyto-radiological relationship between the IAC Yokohama System for Reporting Breast FNAC and the ACR BI-RADS classification in 104 patients presenting with breast lesions at a rural tertiary-care centre. These two systems provide complementary information in the evaluation of breast lesions: BI-RADS offers standardized radiological risk stratification based on imaging characteristics, whereas the Yokohama System categorizes cytological findings according to their risk of malignancy. Their combined interpretation can therefore facilitate a more comprehensive assessment and appropriate selection of patients for further tissue diagnosis.[8]

In our study, BI-RADS 3 was the most frequent radiological category (40.4%), followed by BI-RADS 4 (39.4%), while BI-RADS 2 accounted for 17.3% and BI-RADS 5 for 2.9% of cases. No lesion was categorized as BI-RADS 1. On cytological evaluation, Yokohama C2 (benign) was the predominant category (47.1%), followed by C3 (atypical) in 26.9% of cases. C1, C4 and C5 constituted 7.7%, 2.9% and 15.4%, respectively. The relatively high proportion of C3 lesions is clinically relevant because atypical cytological findings represent an intermediate diagnostic category in which correlation

with imaging and, where indicated, histopathology is particularly important.

The cross-tabulation demonstrated an overall tendency for increasing BI-RADS category to be associated with increasing Yokohama category. Among BI-RADS 2 lesions, 13 of 18 were classified as C2, while among BI-RADS 3 lesions, 22 of 42 were C2 and 10 were C3. The relationship was particularly evident among BI-RADS 4 lesions. Of the 27 BI-RADS 4A lesions, 14 were C2 and 13 were C3, reflecting the heterogeneous nature of this low-suspicion category. In contrast, all 12 BI-RADS 4C lesions were categorized as Yokohama C5, demonstrating a strong association between a higher degree of radiological suspicion and malignant cytology. Of the three BI-RADS 5 lesions, one each was categorized as C3, C4 and C5.

When the categories were broadly grouped into BI-RADS I–III and IV–V, the same trend was observed. All eight C1 cases were associated with BI-RADS I–III, whereas all three C4 cases were associated with BI-RADS IV–V. Among the 16 C5 lesions, 13 were associated with BI-RADS IV–V and three with BI-RADS I–III. The C3 category showed an equal distribution, with 14 cases in each BI-RADS group. These findings indicate that although the two systems showed a clear directional relationship, complete one-to-one correspondence was not observed, particularly within the intermediate categories.

Statistical analysis further supported this association, demonstrating a moderate positive correlation between the Yokohama and BI-RADS classifications (Pearson's $r = 0.442$, $p < 0.001$). Thus, higher BI-RADS categories tended to be associated with higher Yokohama categories. The magnitude of correlation is important because it demonstrates that the two systems are related but do not provide identical information. This is expected because BI-RADS evaluates imaging morphology and radiological characteristics, whereas FNAC assesses cellular morphology. Consequently, cyto-radiological discordance should not necessarily be considered a failure of either modality but rather an indication for closer clinical and radiological-pathological correlation.

Our findings are broadly comparable with those reported in previous studies. Das et al.[9] evaluated 60 breast lesions and reported a statistically significant association between the IAC cytological category and BI-RADS score ($p = 0.004$), with benign cytological categories predominantly occurring in lower BI-RADS categories and malignant categories more frequently associated with higher BI-RADS scores. Similarly, Yadav et al.[10] reported a significant association between the Yokohama and BI-RADS systems and emphasized their complementary role in breast lesion risk stratification. Sundar et al.[11] also demonstrated the complementary diagnostic value of FNAC-based Yokohama classification and BI-RADS in the assessment of breast lesions. Presswala et al.[12] reported 85% concordance between BI-RADS and the Yokohama reporting system, while Ahuja et al.[13] demonstrated significant diagnostic utility of the Yokohama classification and supported its role in standardized breast FNAC reporting.In comparison with these studies, our study demonstrated a moderate positive correlation ($r = 0.442$) rather than complete agreement. Differences in the strength of association between studies

may be related to variations in sample size, patient selection, prevalence of malignancy, distribution of BI-RADS categories, imaging modality and statistical methodology. Importantly, the consistent finding across these studies is that radiologically suspicious lesions are more likely to demonstrate higher-risk cytological categories.

The intermediate categories deserve particular attention. In our study, 14 of 49 C2 lesions were associated with BI-RADS IV–V, while three of 16 C5 lesions occurred within BI-RADS I–III. Furthermore, C3 lesions were equally distributed between the lower- and higher-risk BI-RADS groups. Such discordance is clinically important because imaging and cytology assess different morphological characteristics and may therefore yield apparently discrepant findings. A suspicious imaging appearance may result from architectural distortion, irregular margins or other morphological features that cannot always be adequately assessed by FNAC, while cytological atypia may occasionally be identified in lesions that do not demonstrate overtly suspicious imaging features. These cases emphasize the importance of radiological-pathological correlation and appropriate histopathological confirmation when indicated, rather than relying on either modality independently.

The findings have particular relevance in a rural tertiary-care setting, where accessibility, affordability and timely diagnosis are important considerations. FNAC is minimally invasive, relatively inexpensive and capable of providing rapid diagnostic information. Reporting according to the Yokohama System further standardizes cytological communication by clearly separating benign, atypical, suspicious and malignant categories.[6] BI-RADS, meanwhile, provides a standardized framework for radiological risk assessment and facilitates communication between radiologists, pathologists and treating clinicians.[7] The integration of these approaches may therefore help in rational triaging of patients, particularly those requiring core needle biopsy or other definitive tissue diagnosis.

The study has certain limitations. It was a single-centre study with a relatively modest sample size of 104 cases, and histopathological confirmation was available in only 60 cases because clinically and radiologically benign lesions did not routinely undergo invasive evaluation. Therefore, the findings primarily demonstrate the association between Yokohama and BI-RADS categories rather than the diagnostic accuracy of their combined application in all breast lesions. The small number of BI-RADS 5 and Yokohama C4 cases also limits the strength of conclusions regarding these individual categories.

Despite these limitations, the present study provides useful evidence supporting a coordinated cyto-radiological approach to breast lesion assessment. The significant moderate positive correlation observed between the IAC Yokohama and BI-RADS systems indicates that increasing radiological suspicion generally parallels increasing cytological risk. However, the presence of discordant and intermediate-category lesions highlights the fact that these systems are complementary rather than interchangeable. Their combined interpretation, particularly in radiologically or cytologically

indeterminate cases, can improve communication among radiologists, pathologists and clinicians and help identify patients who require further tissue evaluation.

CONCLUSION

In conclusion, the present study demonstrates a statistically significant moderate positive correlation between the IAC Yokohama and BI-RADS classification systems. The observed relationship supports the complementary use of standardized cytological and radiological reporting in the evaluation of breast lesions, particularly in resource-constrained settings. Rather than replacing one modality with another, integration of both systems can facilitate risk stratification, recognition of discordant lesions and appropriate selection of patients for histopathological confirmation.

Conflict of Interest

None declared.

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