



Original Article

Assessment of risk of malignancy and accuracy of breast fine needle aspiration specimens using the International Academy of Cytology Yokohama System

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ABSTRACT

Keywords:

IAC Yokohama system;
Breast cytology;
Breast FNAB;
Risk of malignancy

Background: Fine-needle aspiration biopsy is the most commonly used procedure due to its cost-effectiveness and reliability. This study aimed to categorize breast specimens according to the International Academy of Cytology Yokohama classification system and to assess and calculate the risk of malignancy, diagnostic accuracy as compared to histopathological diagnosis, identify the system's pitfalls, and evaluate its implications in low-resource or financially constrained settings.

Materials and Methods: A total of 160 breast were studied over a period of six months in patients presenting with palpable breast lumps. The cytology slides were re-categorized using the IAC Yokohama system into five categories. Follow-up histopathology was available for 102 cases.

Results: FNAB specimens were categorized according to the IAC Yokohama system as: insufficient 6.2% (n = 4), benign 72.5% (n = 70), atypical 6.2% (n = 8), suspicious of malignancy 2.5% (n = 2), and malignant 12.5% (n = 18). The risk of malignancy in the benign category was 2%, and in the malignant category was 100%, while sensitivity of the fine needle aspiration cytology was: 90.9%, specificity: 100%, positive predictive value: 100%, negative predictive value 97.1%, and the diagnostic accuracy 97.7%.

Conclusions: Yokohama system aligns well with the histopathological diagnosis, with histopathology considered the gold standard. The IAC Yokohama protocol has shown significant improvement and standardization in the reporting of breast.

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INTRODUCTION

Breast cancer is one of the most common cancers affecting women globally and causing widespread cancer-related mortality. In developed countries, carcinoma of the breast is the second leading cause of cancer-related deaths in women.¹ In India, the incidence is 26 per 100,000 women, with the mortality rate reaching up to 13 per 100,000 women.² These statistics thus highlight the importance of discussing, studying, and improving cancer diagnostics for optimizing patient care. Most countries follow the 'triple test' evaluation protocol for examining breast lumps involving a tri-pronged

approach of clinical, radiological, and fine needle aspiration cytological fine needle aspiration biopsy (FNAC) studies.³ In resource-limited settings, FNAB is the most common procedure considering its cost-effectiveness and reliability in a minimally invasive and fast procedural background.⁴ It has a high sensitivity of 90-95% with a high positive predictive value of 100%.⁵⁻⁷ To optimize this further, in 2016, the International Academy of Cytology (IAC), a group of pathologists, radiologists, surgeons, and oncologists, established a more comprehensive and standardized protocol for all breasts.⁸ A classification was proposed comprising 5 categories with associated risk of malignancy (ROM) and a subsequent suggested management protocol.⁹ Following are the diagnostic categories under this classification, which were outlined: 1. Insufficient/inadequate, 2. Benign, 3. Atypical, 4. Suspicious of malignancy and 5. Malignant. This system has been applied in most medical institutions to improve performance, interpretation, reporting, and provide appropriate objective information to clinicians. Thus, improving mutual communication between the diagnostic limb and its clinical counterparts makes the treatment protocols more focused, improving care and management. With this in mind, this study was conducted to determine the risk of malignancy (ROM) and statistical parameters like sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), of breast FNA diagnosed as per IAC Yokohama classification, and also diagnostic accuracy, as compared to final histopathological diagnosis.

MATERIALS AND METHODS

A total of 160 breast FNAC samples were studied over a period of six months. Both inpatient and outpatient demographic populations with complaints of palpable breast lumps, irrespective of age group, were included in the study. All relevant clinicopathological details, such as demography, clinical course during the duration of stay at the hospital, radiological studies, and cytology reports, were noted and reviewed. Further, USG-guided FNA samples, which were insufficient, were excluded. The cytology slides were processed as per the institution's protocol, analysed, re-categorized, and re-appraised using the IAC Yokohama system into 5 categories. Further follow-up histopathology was available for 102 cases; thus, correlation with histopathological findings was performed wherever available. To assess diagnostic accuracy, the receiver operating characteristic (ROC) curve was plotted. Further, the specimens were categorized according to the IAC Yokohama System, and the utility of the protocol, along with its pitfalls, was assessed, keeping in mind the implications of resource-limited set-ups. The ratio of confirmed malignant cases to all cases in each diagnostic category was calculated to know the ROM for each category, and the ROC curve was constructed. Further, considering histological examination as the gold standard, other statistical parameters were also calculated. The study was conducted after approval from the institutional ethics committee.

RESULTS

A total of 160 FNAC cases were categorized according to the IAC Yokohama system after review and reappraisal by experienced pathologists, along with correlation of 102 cases with their corresponding histopathological diagnoses. Further, demographic classification according to age and sex distribution was also studied. The majority of the study population were female patients (96.2%, n=154), with males comprising 3.8% (n=6). Patients' ages ranged from 11 to 60 years, with most cases in the 31–40 years age group (n=58, 36.5%), followed by 21–30 years (n=40, 25%). Of 160 FNAC cases, 72.5% (n=116) were categorized as benign, 12.5% (n=20) malignant, 6.2% (n=10) atypical, 6.2% (n=10) insufficient, and 2.5% (n=4) suspicious for malignancy. Most benign (n=44) and atypical (n=6) cases occurred in the 31–40 years group, malignant cases (n=14) in the 41–50 years group, and suspicious cases (n=4) were equally distributed between the 31–40 and 41–50 years age groups. Out of these cases, 102 cases had a follow-up histopathological diagnosis. Cytopathology-histopathology correlation in each category of histopathologically proven invasive breast carcinoma was misclassified as benign on cytology (Tables 1, 2). The error was seen to arise due to the deep-seated location of the lesions, making aspiration difficult and thus leading to scant cellularity on the smear. Also, two cases of ductal papilloma were categorized as atypical due to hypocellular smears with the presence of a few atypical cells. Based upon the smear findings and taking Yokohama categories into consideration, the FNA smears were classified into two groups of benign and malignant lesions. Insufficient, benign, and atypical categories were considered under the benign group. Suspicious for malignancy and malignant category are considered under the malignant group. Thus, the sensitivity of the test was seen to be 90.9% with a 100% specificity, having a positive predictive value (PPV) of 100% and a negative predictive value (NPV) of 97.1%, all culminating in a diagnostic accuracy of 97.7%. The generated ROC curve provides insight into the diagnostic accuracy of the model.

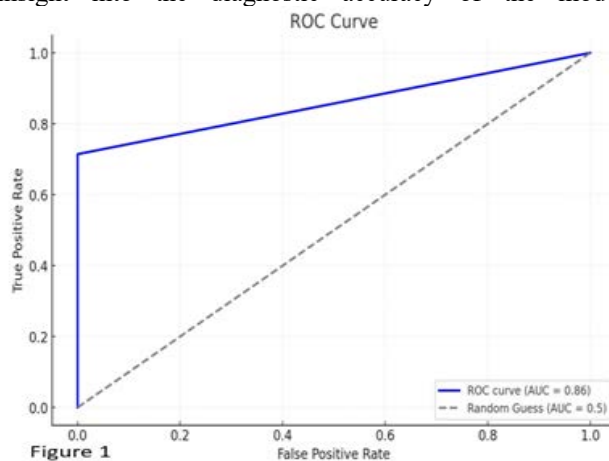


Figure 1: Receiver operating characteristic (ROC) curve

In our study, the curve's position above the diagonal line suggests that the model has a fair discriminative ability,

performing better than random chance. The AUC (Area Under Curve) value further supports this, indicating the diagnostic categories of the International Academy of Cytology Yokohama System align with the histopathological

diagnosis, considering histopathology as a gold standard. It reflects the potential clinical utility of the International Academy of Cytology Yokohama System in aiding diagnostic decision-making.

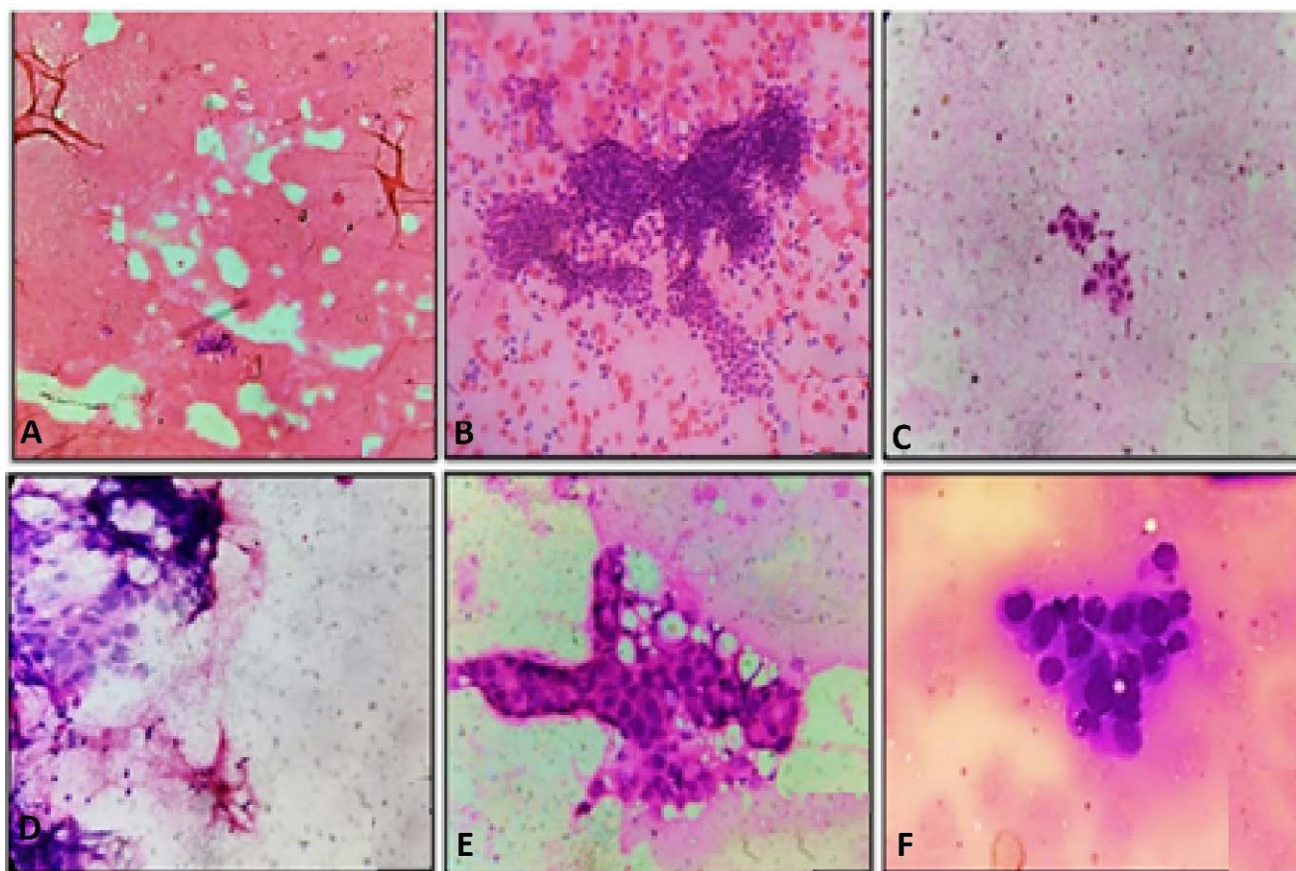


Figure 2: Microscopic findings of examples from each category: (A) Inadequate category—Single cluster of cells against a hemorrhagic background (HE stain, 100X). (B) Benign category—sheets of cohesive monotonous cells in a typical staghorn pattern, bare bipolar nuclei – fibroadenoma (HE stain, 400x). (C) Atypical category – Clusters of atypical cells with a high N:C ratio (HE stain, 40x). (D) Suspicious for malignancy category – Smear showing dyscohesive clusters of cells with a mild to moderate degree of nuclear enlargement (HE stain, 400x). (E,F) Malignant category – Loosely cohesive cluster showing medium to large-sized cells with nuclear pleomorphism, hyperchromatic nuclei, and nuclear atypia (HE stain, 400x)

Table 1: Cytopathology-histopathology correlation

Category	Cytology Diagnosis	No. of Cases	Histopathology Diagnosis	No. of Cases
Insufficient	Insufficient	4	Fibrocystic mastopathy	4
Benign	Fibroadenoma	70	Fibroadenoma	40
			Suppurative inflammation	1
			Sclerosing adenosis	1
			Benign phyllodes	4
			Complex fibroadenoma	1
	Proliferative breast disease without atypia		Fibroadenoma	10
	Suppurative granulomatous inflammation		Invasive breast carcinoma	2
	Gynecomastia		Suppurative pathology	8
			Gynecomastia	3
Atypical	Atypical	8	Highly suspicious of IDC (NOS)	6
			Duct papilloma	2
Suspicious of malignancy	Suspicious of malignancy	2	Invasive breast carcinoma (NST)	2
Malignant	Duct carcinoma	18	Invasive ductal carcinoma	18
Total		102		102

DISCUSSION

In our study, 160 cases were re-categorized according to the IAC Yokohama system. ROM of each category and statistical parameters for diagnostic accuracy were calculated. 96.2% of the study population were female patients. 96.2% and only 3.7% of patients were male, which is in concordance with the study of Seth V. et al.⁹, where only 3.3% of the population were male. The majority of cases were in the age group of 31–40 years (36.2%), which was in concordance with many previous studies of Agnani et al.¹⁰, Sunitha et al.¹¹, Sreedevi et al.¹², and Badge et al.¹³ Also, there were no malignant cases in the age group of 11–30 years, which is again comparable to previous studies of Sunitha et al., Badge et al., and Sreedevi et al.^{11–13} In the present study, the majority of atypical cases were also in the age group of 31–40 years. The maximum number of cases in categories of suspicious for malignancy and malignant were in the age group of 41–50 years, which is younger than the usual reported age of malignancy. The IAC Yokohama system was studied and applied to the smears, keeping in mind the algorithmic approach defined under its purview.

In present study, maximum number of cases were diagnosed as benign [n=70 cases (72.5%)], which is comparable to previous studies like Agnani et al.¹⁰, Sunita et al.¹¹, Montezuma et al.¹⁴ and Kamatar et al.¹⁵ The majority of studies in the literature show more than 50% of cases of breast FNABs to be benign. Exceptions to these findings are previous studies by Wong et al.¹⁶ and De Rosa et al.¹⁷, where less than 50% of cases in the study were in the benign category. The majority of studies show a minimum number of cases in the suspicious of malignancy category. In the present study, only 2 cases (2.5%) were observed in the suspicious of malignancy category. This finding is

comparable to studies of Kamatar et al.¹⁵, Chouhan et al.¹⁸, Panwar et al.¹⁹ and Wong YP et al.²², where around 2% of cases were in the category of suspicious for malignancy. The inadequate category had 6.2% of cases due to inadequate/insufficient material for reporting, which is comparable to the previous study of Montezuma et al.¹⁴ and Wong et al.¹⁶ 6.2% of cases were observed in the atypical category, which is comparable to previous studies of Panwar et al.¹⁹ and Agarwal et al.²⁰ The malignant category shows 12.5% of cases, which is comparable to the study by Sunitha et al.¹¹ All cases of insufficient category (n=4 cases) were diagnosed as benign lesions on histopathology, which is comparable to the study by Seth et al.⁹ It may be due to failure to aspirate lesions on FNA, which were inadequate for reporting. In the present study, the commonest benign lesion was fibroadenoma (n = 50 cases) out of 70 cases of the benign category on cytopathology. This finding is in concordance with previous studies by Seth et al.⁹, Agnani et al.¹⁰ and Dogra et al.²¹, where the commonest lesion in the benign category was fibroadenoma. Two cases of benign category turned out to be invasive breast carcinoma (NST). These findings emphasize the possibility of sampling error in palpation-guided FNABs. There were 6 cases of gynecomastia in the benign category of cytology, out of which 3 cases were confirmed in histopathology. In histopathology, cases of atypical category (n=8 cases) were diagnosed as highly suspicious of IDC (NOS) in 6 cases and duct papilloma in 2 cases. The IAC Yokohama system recommends that smears with low cellularity but atypical cells should be placed in the atypical category. All cases of suspicious malignancy category (n=2 cases) were confirmed as invasive breast carcinoma on histopathology. Also, all cases of the malignant category (n=18 cases) were confirmed on histopathology as duct carcinoma. These findings are

comparable to a previous study by Dogra et al.²¹, where all cases suspicious of malignancy and malignant category turned out to be malignant on histopathology also. The risk of malignancy was calculated for each category as shown in Table 2. The risk of malignancy of the insufficient category was 0%, which was in concordance with Seth et al.⁹, Sunitha et al.¹¹ and Panwar et al.¹⁹ studies; 2 cases of the benign category turned out to be malignant on histopathology. Thus, the ROM of the benign category was 2%, which was in concordance with Wong et al.'s study.¹⁶ ROM was 75% in the atypical category, which is slightly higher than the previous study of Kamatar et al.¹⁵ where the observed ROM was 66%. This further emphasizes the need for increased vigilance in categorizing suspicious lesions into an atypical category, which may turn out to be malignant later. Thus, a keen eye and increased observer sensitivity to such atypical cases is the need for increasing diagnostic accuracy. The risk of malignancy was 100% for the category of suspicious for malignancy, which is comparable to the study of Montezuma et al.¹⁴ and 100% for the malignant category, which is in concordance with many previous studies of Montezuma et

al.¹⁴, Chauhan et al.¹⁸, Panwar et al.¹⁹, Agarwal et al.²⁰ and Wong YP et al.²² The statistical parameters were calculated and compared with other studies (Table 3). In the present study, we observed 90.9% sensitivity and positive predictive value, which is in concordance with the study by Dogra et al.²¹ Also, we observed 97.7% diagnostic accuracy, which is comparable to the study of Sunitha et al.¹¹ A comparison of statistical parameters with other studies is depicted in Table 3. The generated ROC curve provides insight into the diagnostic accuracy of the model. In our study, the curve's position above the diagonal line suggests that the model has a fair discriminative ability, performing better than random chance. The AUC (Area Under Curve) value further supports this, indicating the diagnostic categories of the International Academy of Cytology Yokohama System align with the histopathological diagnosis, considering histopathology as a gold standard. It reflects the potential clinical utility of the International Academy of Cytology Yokohama System in aiding diagnostic decision-making.

Table 2: Comparative analysis of the Risk Of Malignancy (ROM) in each category in different studies

Study	Inadequate	Benign	Atypical	Suspicious for malignancy	Malignant
Wong et al. ¹⁶ (n=579)	2.6	1.7	16	84.6	99.5
De Rosa et al. ¹⁷ (n=1745)	49.6	4.9	21	78.7	98.8
Agarwal et al. ²⁰ (n=321)	60.9	8.3	17	77.8	100
Panwar et al. ¹⁹ (n=108)	0	0	0	75	100
Wong YP et al. ²² (n=521)	13.6	0.4	25	85.7	100
Present study(n=102)	0	2	75	100	100

Table 3: Comparative analysis of statistical parameters in different studies

Statistical parameters	Present study	Dogra et al. ²¹	Kamatar et al. ¹⁵	Montezuma et al. ¹⁴	Sunitha et al. ¹¹
Sensitivity	90.9%	74.07%	97%%	97.56%	100%
Specificity	100%	100%	94%	100%	96.66%
Positive predictive value	100%	100%	91%	100%	94.59%
Negative predictive value	97.1%	86%	98%	98.62%	100%
Diagnostic accuracy	97.7%	90%	95%	99.11%	97.89%

CONCLUSIONS

The high sensitivity, specificity, and overall diagnostic accuracy observed in this study underscore the effectiveness of the IAC Yokohama system in the evaluation of breast FNAC. The excellent positive and negative predictive values reflect its reliability in correctly classifying both malignant and benign lesions. The graded increase in risk of malignancy across categories—particularly the high ROM in the “suspicious for malignancy” and “malignant” categories—highlights the system’s robust risk stratification and clinical relevance. By providing standardized, reproducible categories with defined malignancy risks, the Yokohama system enhances diagnostic confidence, improves communication between cytopathologists and clinicians, and facilitates appropriate clinical decision-making. Its high diagnostic performance and cost-effectiveness further support its utility as a valuable diagnostic tool, especially in resource-limited settings.

Conflicts of interest: None

REFERENCES

- Bray F, Laversanne M, Sung H, Ferlay J, Siegel RL, Soerjomataram I, et al. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin*. 2024;74:229–63. [Crossref](#)
- Mehrotra R, Yadav K. Breast cancer in India: Present scenario and the challenges ahead. *World J Clin Oncol*. 2022;13:209–18. [Crossref](#)
- Field AS, Raymond WA, Rickard MT, Arnold L, Brachtel EF, Chaiwun B, et al. The International Academy of Cytology Yokohama System for Reporting Breast Fine Needle Aspiration Biopsy Cytopathology: Introduction and Overview. In: Field AS, Raymond WA, Schmitt F, eds. *The International Academy of Cytology Yokohama System for Reporting Breast Fine Needle Aspiration Biopsy Cytopathology*. Cham, Switzerland: Springer International Publishing; 2020:1-9
- Field AS, Raymond WA, Rickard MT, Arnold L, Brachtel EF, Chaiwun B, Chen L, et al. The International Academy of Cytology Yokohama System for Reporting Breast Fine-Needle Aspiration Biopsy Cytopathology. *Acta Cytol*. 2019;63(4):257-73. [Crossref](#)
- Kamal MZ, Banu NR, Alam MM, Das UK, Karmoker RK. Evaluation of breast lump: comparison between tru-cut needle biopsy and FNAC in MMCH: a study of 100 cases. *Mymensingh Med J*. 2020;29:48–54. PMID: 31915335
- Gandhi H, Maru A, Shah N, Mansuriya RK, Rathod G, Parmar P. Correlation of Robinson’s cytological grading with Elston and Ellis’ Nottingham modification of Bloom Richardson score of histopathology for breast carcinoma. *Maedica (Buchar)*. 2023;18:55–60. [Crossref](#)
- Montezuma D, Malheiros D, Schmitt FC. Breast fine needle aspiration biopsy cytology using the newly proposed IAC Yokohama system for reporting breast cytopathology: the experience of a single institution. *Acta Cytol*. 2019;63:1–6. [Crossref](#)
- Field AS, Schmitt F, Vielh P. IAC standardized reporting of breast fine-needle aspiration biopsy cytology. *Acta Cytol*. 2017;61:3–6. [Crossref](#)
- Seth V, Sharma A. Cytohistological spectrum of breast lesions with respect to the IAC Yokohama system for reporting breast fine aspiration cytology: a two-year tertiary care center experience. *Int J Sci Res*. 2023;12:29–31. [Crossref](#)
- Agnani B, Hemrajani D, Mathur K, Agnani S. Breast cytopathology reporting using the newly proposed IAC Yokohama system: a single institutional retrospective study of the application of the system and utility of breast FNAC. *Int J Sci Res*. 2020;9(3):1-3. [Crossref](#)
- Krishna Kanth G, Sunitha A, Chandra S. Application of IAC Yokohama system for breast cytology: the experience at a tertiary care hospital. *IP Arch Cytol Histopathol Res*. 2021;6:237–42. DOI: <https://doi.org/10.18231/j.achr.2021.053>
- Sreedevi CH, Pushpalatha K. Correlative study of FNAC and histopathology for breast lesions. *Trop J Pathol Microbiol*. 2016;2:206–11. [Crossref](#)
- Badge S, Ovhal A, Azad K, Meshram A. Study of fine-needle aspiration cytology of breast lumps in rural area of Bastar district, Chhattisgarh. *Med J Dr D Patil Univ*. 2017;10:339. Available from: [Weblink](#)
- Montezuma D, Malheiros D, Schmitt FC. Breast fine needle aspiration biopsy cytology using the newly proposed IAC Yokohama system for reporting breast cytopathology: The experience of a single institution. *Acta Cytol* 2019;63:1–6. [Crossref](#)
- Kamatar PV, Athanikar VS, Dinesh US. Breast fine needle aspiration biopsy cytology reporting using International Academy of Cytology Yokohama system: two-year retrospective study in a tertiary care centre in southern India. *Natl J Lab Med*. 2019;8:e2362. [Crossref](#)
- Wong S, Rickard M, Earls P, Arnold L, Bako B, Field AS, et al. The International Academy of Cytology Yokohama system for reporting breast fine needle aspiration biopsy cytopathology: a single institutional retrospective study of the application of the system categories and the impact of rapid onsite evaluation. *Acta Cytol*. 2019;63:280–91. [Crossref](#)
- De Rosa F, Migliatino I, Vigliar E, Salatiello M, Pisapia P, Iaccarino A, et al. The continuing role of breast fine-needle aspiration biopsy after the introduction of the IAC Yokohama system for reporting breast fine needle aspiration biopsy cytopathology. *Diagn Cytopathol*. 2020;48:1244–53. [Crossref](#)
- Chauhan V, Pujani M, Agarwal C, Chandoke RK, Raychaudhuri S, Singh K, et al. IAC standardized reporting of breast fine-needle aspiration cytology, Yokohama 2016: a critical appraisal over a two-year period. *Breast Dis*. 2019;38:109–15. [Crossref](#)
- Panwar H, Ingle P, Santosh T, Singh V, Bugalia A, Hussain N. FNAC of breast lesions with special reference to IAC standardized reporting and comparative study of cytohistological grading of breast carcinoma. *J Cytol*. 2020;37:34–9. [Crossref](#)
- Agarwal A, Singh D, Mehan A, et al. Accuracy of the International Academy of Cytology Yokohama system of breast cytology reporting for fine needle aspiration biopsy of the breast in a dedicated breast care setting. *Diagn Cytopathol*. 2021;49:195–202. [Crossref](#)
- Dogra A, Singh D, Pant P, Joshi U, Pandey HS. Cytological evaluation of fine needle aspiration of breast lesions using IAC Yokohama classification system for reporting breast cytopathology. *J Med Sci Health*. 2023;9:245–50. [Crossref](#)
- Wong YP, Vincent James EP, Mohammad Azhar MAA, et al. Implementation of the International Academy of Cytology Yokohama standardized reporting for breast cytopathology: An 8-year retrospective study. *Diagn Cytopathol*. 2021;49(6):718-26. [Crossref](#)