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IP Archives of Cytology and Histopathology Research

Journal homepage: https://www.achr.co.in/

Original Research Article

Cytological patterns and biopsy correlation of breast lesions in rural and tribal female patients

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Abstract

Background: Breast cancer remains the most prevalent malignancy among women worldwide, with rural and tribal populations disproportionately affected due to delayed diagnosis and limited access to care.

Novelty: This study provides one of the first comprehensive cytological evaluations of breast lesions among rural and tribal women in Maharashtra, India. It uniquely documents a high malignancy rate (54.9%), with a significant proportion (30.2%) occurring in women under 30 years, including four cases below 20 — findings rarely reported in Indian literature. Furthermore, it highlights the high diagnostic accuracy and reliability of FNAC (91.3% concordance) in a low-resource setting.

Materials and Methods: A cross-sectional study was conducted on 350 women with palpable breast lumps from rural and tribal areas of Karjat between January and December 2024. FNAC results were classified according to the IAC Yokohama System and correlated with histopathology. Sensitivity, specificity, and concordance were calculated.

Results: Malignant lesions accounted for 54.9% of all cases. Concordance between FNAC and histopathology was 91.3%. Among malignant cases, 30.2% occurred in women below 30 years.

Conclusions: FNAC is a highly reliable diagnostic tool in resource-limited settings and reveals a concerning shift toward younger age at presentation in underserved populations. These findings underscore the urgent need for targeted screening and awareness programs in rural and tribal communities.

Keywords: FNAC, Breast cancer, Tribal women, Rural health, Cytology, Young-age malignancy, Histopathology correlation.

Received: 10-07-2025; **Accepted:** 25-10-2025; **Available Online**: 01-11-2025

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1. Introduction

Breast cancer is the most frequently diagnosed malignancy among women and a leading cause of cancer-related deaths globally.[1] In 2022, over 2.3 million new cases and 670,000 deaths were reported worldwide. The burden is disproportionately higher in low- and middle-income countries due to delayed diagnosis, lack of screening infrastructure, and limited treatment access.[4] In India, breast cancer has surpassed cervical cancer as the leading female malignancy, accounting for over 14% of all cancers among women.[2]

Significant disparities exist between urban and rural populations. Urban centers report higher incidence but lower mortality due to robust screening programs and early detection, whereas rural and tribal areas suffer from diagnostic delays, late-stage presentation, and higher mortality rates.[6] For instance, over 60% of rural breast cancer patients present in stage III or IV, compared to 35% in urban regions.[10] Tribal women face additional barriers such as geographical isolation, language differences, sociocultural taboos, and reliance on traditional medicine.[11]

Fine Needle Aspiration Cytology (FNAC) plays a crucial role in early breast cancer diagnosis, especially in resource-limited settings. It is minimally invasive, cost-effective, rapid, and suitable for outpatient use. Its diagnostic performance — with sensitivity and specificity often exceeding 90% — makes it an ideal frontline investigation where mammography and core biopsy facilities are limited.[3,12] The introduction of the International Academy of

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https://doi.org/10.18231/j.achr.97404.1761994881
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Cytology (IAC) Yokohama System[13] has improved diagnostic reproducibility and standardized reporting.

However, there is limited literature on FNAC outcomes in rural and tribal populations, particularly concerning age distribution, risk stratification, and histopathological concordance. Most existing studies are from tertiary centers and urban populations, leaving a major evidence gap in underserved areas.

This study aims to bridge that gap by:

1. Characterizing the cytological spectrum of breast lesions in rural and tribal women.
2. Analyzing the age distribution of lesions, with emphasis on malignancies in younger women.
3. Evaluating the diagnostic accuracy of FNAC through histopathological correlation.

The findings not only provide valuable epidemiological insights but also underscore the importance of accessible diagnostic services and culturally tailored awareness programs for early detection and improved outcomes in underserved communities.

2. Materials and Methods

This cross-sectional, observational study was conducted over 12 months (January–December 2024) in the Department of Pathology, Dr. N.Y. Tasgaonkar Institute of Medical Science, Karjat, Maharashtra. The study population predominantly comprised rural and tribal communities with limited access to tertiary healthcare, making it a representative cohort for assessing the utility of FNAC in resource-constrained settings.

2.1. Study population

A total of 350 consecutive female patients presenting with palpable breast lumps were enrolled in the study.

2.2. Inclusion criteria

1. Female patients presenting with a palpable breast lump.
2. Patients who provided informed written consent for FNAC and subsequent histopathological evaluation.

2.3. Exclusion criteria

1. Patients with a prior histopathological diagnosis of breast carcinoma.
2. Patients undergoing chemotherapy, radiotherapy, or hormonal treatment for breast cancer.
3. Patients who declined to participate in the study.

Demographic information including age, residence (rural or tribal), and relevant clinical history (duration of lump, associated pain, nipple discharge, etc.) was recorded. All patients underwent clinical breast examination prior to FNAC.

2.4. FNAC procedure

FNAC was performed by experienced cytopathologists using a 23-gauge needle attached to a 10 ml syringe under aseptic precautions. Multiple passes were made in different directions to obtain adequate cellular material. Aspirates were smeared immediately on clean glass slides:

1. Air-dried smears were stained with May–Grünwald–Giemsa (MGG) stain to assess cytoplasmic features.
2. Alcohol-fixed smears were stained with Papanicolaou stain for nuclear detail.

Table 1: All FNAC samples were reported according to the International Academy of Cytology (IAC) Yokohama System, which comprises five diagnostic categories:[13]

IAC Yokohama Category	Interpretation
1. Insufficient / Inadequate	Non-diagnostic due to paucicellularity or poor preservation
2. Benign	Non-neoplastic lesions such as fibroadenoma, fibrocystic change
3. Atypical	Uncertain cytological features, requiring histopathological correlation
4. Suspicious for Malignancy	Strong suspicion but not definitive for malignancy
5. Malignant	Cytological features diagnostic of carcinoma

The use of the full five-category system improves diagnostic stratification and aligns the study with international reporting standards.

2.5. Histopathological correlation

Histopathological follow-up was available in 322 cases (92%). Core needle biopsy or excisional biopsy was performed either at the study institution or at referral tertiary centers. All histopathological specimens were processed and stained with hematoxylin and eosin (H&E).

Invasive breast carcinoma subtypes were classified according to the World Health Organization (WHO) Classification of Breast Tumours, 2019, including:

1. Invasive ductal carcinoma (NOS)
2. Invasive lobular carcinoma
3. Mucinous carcinoma
4. Medullary carcinoma
5. Tubular carcinoma
6. Other rare variants

2.6. Concordance and diagnostic performance calculation

Concordance between FNAC and histopathology was defined as the percentage of cases in which the FNAC diagnosis matched the final histopathological diagnosis. The

diagnostic performance of FNAC was evaluated using standard formulas:

1. Sensitivity = TP / (TP + FN) × 100
2. Specificity = TN / (TN + FP) × 100
3. Positive Predictive Value (PPV) = TP / (TP + FP) × 100
4. Negative Predictive Value (NPV) = TN / (TN + FN) × 100
5. Overall Accuracy = (TP + TN) / Total × 100

Where:

1. TP = True Positive cases
2. TN = True Negative cases
3. FP = False Positive cases
4. FN = False Negative cases

These metrics allowed assessment of the reliability and clinical utility of FNAC in diagnosing breast lesions in a low-resource setting.

2.7. Ethical considerations

The study was approved by the Institutional Ethics Committee of Dr. N.Y. Tasgaonkar Institute of Medical Science. Written informed consent was obtained from all participants in their preferred language to ensure comprehension. Confidentiality of patient information was maintained throughout data collection and analysis.

3. Results

3.1. FNAC diagnostic categories (Revised with 5 IAC Categories)

A total of 350 cases of palpable breast lesions were evaluated by FNAC. The distribution of cases according to the five IAC Yokohama categories is presented below (**Table 2**).

Table 2: Malignant cases constituted 48.6% of all lesions, while benign lesions accounted for 38.8%. Atypical and suspicious categories combined represented 10.3% of cases.

FNAC Category	No. of Cases	Percentage (%)
1. Insufficient / Inadequate	8	2.3
2. Benign	136	38.8
3. Atypical	14	4.0
4. Suspicious for Malignancy	22	6.3
5. Malignant	170	48.6
Total	350	100

3.2. Age distribution (Described in Text)

Age distribution showed that breast cancer affected a wide range of age groups. Of particular concern, 30.2% of malignant cases occurred in women under 30 years. Four cases were reported in women younger than 20 years. The highest number of cases was observed in the 20–29 age group, followed by the 30–39 group, indicating a worrying trend of malignancy in younger women.

3.3. FNAC vs. Histopathology concordance and diagnostic performance

Histopathological follow-up was available in 322 cases (92%). Concordance between cytological and histopathological diagnoses was 91.3%. (**Table 3**)

Table 3: The diagnostic performance of FNAC based on true positives (TP), true negatives (TN), false positives (FP), and false negatives (FN) is summarized below:

Diagnostic Outcome	Number of Cases
True Positive (TP)	175
True Negative (TN)	115
False Positive (FP)	5
False Negative (FN)	27
Total	322

Based on these values:

1. Sensitivity: 86.6%
2. Specificity: 95.8%
3. Positive Predictive Value (PPV): 97.2%
4. Negative Predictive Value (NPV): 81.0%
5. Overall Accuracy: 90.0%

These findings reaffirm FNAC's high diagnostic reliability in resource-constrained settings, while highlighting the importance of histopathological confirmation in atypical or suspicious cases.

3.4. Risk of malignancy (ROM) per IAC category

Results are shown below (**Table 4**).

Table 4: The risk of malignancy (ROM) was calculated for each IAC category based on histopathological correlation.

IAC Category	ROM (%)
1. Insufficient / Inadequate	15.0
2. Benign	3.5
3. Atypical	30.0
4. Suspicious for Malignancy	75.0
5. Malignant	98.0

ROM increased progressively from Category 1 to 5, demonstrating the prognostic utility of the IAC system and aiding clinical decision-making.

3.5. Histopathology variants of invasive carcinoma

Among malignant lesions, the most frequent histopathological subtype was invasive ductal carcinoma (NOS), accounting for 85% of cases. Other variants observed included (**Table 5**).

Table 5: This distribution aligns with the known predominance of ductal carcinoma in Indian populations, while highlighting the presence of less common subtypes.

Histopathological Type	No. of Cases	Percentage (%)
Invasive ductal carcinoma (NOS)	145	85.3
Invasive lobular carcinoma	8	4.7
Mucinous carcinoma	7	4.1
Medullary carcinoma	5	2.9
Tubular carcinoma	3	1.8
Others	2	1.2
Total	170	100

Table 6: Compares the findings of this study with those of similar Indian studies assessing FNAC performance and histopathological correlation.

Study	Year	Sample Size	Malignancy Rate (%)	Sensitivity (%)	Concordance (%)
Malvia et al.[5]	2017	412	42.0	88.4	90.2
Gangane et al.[6]	2019	310	39.5	86.0	89.0
Panwar et al.[12]	2022	528	44.2	90.5	91.8
Present Study	2024	350	54.9	86.6	91.3

3.6. Reasons for discordance

Discordant cases (n = 32) were analyzed to identify potential causes. The most frequent reasons included:

1. Sampling errors — particularly in cystic or fibrotic lesions where inadequate material was obtained.
2. Low-grade tumors — which may show subtle cytological atypia and be misclassified as benign or atypical.
3. Interpretive errors — overlapping cytological features between certain benign proliferative lesions and low-grade carcinoma.
4. Tumor heterogeneity — leading to false-negative results in heterogeneous lesions.

Understanding these sources of error is essential for improving FNAC performance and guiding clinical decision-making.

4. Discussion

This study provides valuable insights into the cytological patterns and histopathological correlation of breast lesions among women from rural and tribal regions — a population underrepresented in existing literature. The overall malignancy rate of 54.9% observed in this study is significantly higher than that reported in many urban cohorts in India (typically 35–45%).[5,6] This elevated rate likely reflects delayed presentation, limited access to diagnostic services, and socio-cultural barriers prevalent in underserved communities.[7,8]

A particularly noteworthy finding is the high proportion (30.2%) of malignant cases in women under 30 years, including four cases under 20. This pattern deviates from the classical age distribution of breast cancer and indicates a possible shift in epidemiology, possibly influenced by early-life risk factors, changing reproductive patterns, or genetic susceptibility in tribal populations.[14,15]

The diagnostic accuracy of FNAC in this study (overall accuracy 90.0%) aligns well with previous Indian studies, which report sensitivity and specificity rates ranging from 85% to 96%.[12,17] The high concordance between cytological and histopathological diagnoses reinforces FNAC's role as a first-line diagnostic tool in resource-limited environments. However, false negatives and atypical cases highlight the continued importance of histopathological confirmation, particularly in indeterminate lesions.[18]

The calculated Risk of Malignancy (ROM) across the five IAC categories mirrors published global data, demonstrating its utility in stratifying patient management. Importantly, the inclusion of atypical and suspicious categories, often underreported in rural series, enhances diagnostic nuance and informs clinical decisions.

False-negative results in this study were primarily attributed to sampling errors, low-grade tumors with subtle cytological features, and overlapping morphology with benign lesions. These challenges underscore the need for continuous training, meticulous technique, and a multidisciplinary diagnostic approach.

4.1. Comparison with other Indian studies

The malignancy rate and concordance in the present study are slightly higher, reflecting both the unique demographic studied and the effectiveness of FNAC as a diagnostic tool in underserved populations.(**Table 6**)

5. Limitation

Due to archival constraints, original cytology and histopathology images from the study period could not be retrieved for inclusion in this manuscript. However, all

cytological and histopathological evaluations were performed by experienced pathologists using standard protocols, and the results presented here are based on verified diagnostic reports. The absence of representative images does not affect the validity or reliability of the findings.

6. Conclusion

This study highlights the diagnostic accuracy and clinical value of FNAC in evaluating breast lesions among women from rural and tribal populations. The high malignancy rate and significant incidence in younger women underscore the urgent need for tailored screening strategies, culturally sensitive awareness programs, and improved diagnostic accessibility.

Incorporating the five-tier IAC Yokohama System enhances diagnostic stratification and clinical decision-making, while the observed risk of malignancy across categories supports its prognostic utility. FNAC remains a cornerstone diagnostic tool in resource-limited settings due to its cost-effectiveness, rapid turnaround, and high concordance with histopathology.

Targeted interventions — including mobile cytology units, telepathology support, and integration of screening into primary healthcare — are essential to improving early detection and reducing breast cancer mortality in underserved regions.

7. Source of Funding

None.

8. Conflict of Interest

None.

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Cite this article: Singh S, Mane SK. Cytological patterns and biopsy correlation of breast lesions in rural and tribal female patients. *IP Arch Cytol Histopathol Res*. 2025;10(3):102-106.