Original Article

Imprint Cytology of Breast Lesions and Its Correlation with Histopathology: A Prospective Study at A Tertiary Care Centre

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Abstract

Background: Imprint cytology is a simple, inexpensive technique that gives a rapid cytological diagnosis while preserving tissue for histopathology. This study evaluated its diagnostic utility in breast lesions by correlation with histopathology. **Material and Methods:** This prospective study included 80 surgically resected breast specimens from female patients aged 18 years and above, received in the Department of Pathology, Dr B R Ambedkar Medical College and Hospital, Bengaluru, from March 2024 to August 2025. Imprint smears prepared from the fresh cut surface were fixed in 95% ethyl alcohol, stained with haematoxylin and eosin, reported as inadequate, negative, suspicious or positive for malignancy, and correlated with the final histopathological diagnosis. **Results:** Patients were aged 26–56 years (mean 41.6 ± 8.6 years). On imprint cytology, 48.75% of smears were negative, 38.75% positive, 8.75% suspicious and 3.75% inadequate. Histopathology showed 43 benign (53.75%) and 37 malignant (46.25%) lesions; fibroadenoma (53.49%) and invasive breast carcinoma NOS (ductal) (81.08%) were the commonest benign and malignant lesions. Excluding inadequate smears and treating suspicious smears as positive, imprint cytology showed a sensitivity of 97.14%, specificity of 90.48%, PPV of 89.47%, NPV of 97.44% and diagnostic accuracy of 93.51%. **Conclusion:** Imprint cytology is a rapid, cost-effective and accurate intraoperative adjunct for differentiating benign from malignant breast lesions, particularly where frozen section facilities are limited. Histopathology remains the gold standard.

Keywords: Imprint cytology, breast neoplasms, histopathology, intraoperative diagnosis, diagnostic accuracy.

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Introduction

Breast cancer is the most commonly diagnosed cancer among women worldwide and a leading cause of cancer-related death, with a heavy burden in developing countries where diagnosis is often delayed.[1] Breast lesions range from inflammatory and benign proliferative conditions to invasive carcinoma, and early distinction between benign and malignant lesions directly influences surgical planning and prognosis. Histopathology is the gold standard, but it takes time, and preoperative fine needle aspiration cytology is limited by sampling error, inadequate cellularity and its inability to separate in situ from invasive carcinoma.[2]

Imprint (touch) cytology is prepared by pressing the freshly cut surface of a tissue onto a glass slide.[3] It is rapid and inexpensive, needs no special equipment, gives crisp nuclear detail free of freezing artefact and leaves the tissue intact for histopathology.[4-6] It is also used for margin assessment and sentinel lymph node evaluation.[7] However, overlap between proliferative benign lesions and low-grade carcinomas, and the poor yield of sclerotic and lobular tumours, can cause errors, so its accuracy must be established against histopathology.[4,8,9] The present study was undertaken to study the imprint cytology of breast lesions, to correlate it with histopathology and to evaluate its diagnostic utility.

Materials and Methods

This prospective study was conducted in the Department of Pathology, Dr B R Ambedkar Medical College and Hospital, Bengaluru, from March 2024 to August 2025, after approval from the Institutional Ethics Committee. Informed consent was obtained from all patients in their own language, and clinical details were collected from the case files. All surgically resected breast lesions in female patients aged 18 years and above were included; autolysed specimens, inadequate samples and male breast lesions were excluded. The sample size, calculated as $n = Z^2pq/d^2$ with $Z = 1.96$, $p = 0.5$ and $d = 0.11$, was 79.3; 80 consecutive cases were therefore studied.

Imprint smears were prepared from suspicious areas of the freshly excised lesion, before formalin fixation, by gently pressing the cut surface against clean glass slides, fixed in 95% ethyl alcohol for 20 minutes and stained with haematoxylin and eosin (H&E). Smears were reported as inadequate, negative for

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malignancy, suspicious for malignancy or positive for malignancy. The specimens were then fixed in 10% formalin, processed routinely, and paraffin sections were stained with H&E and classified according to the WHO classification of breast tumours (5th edition).10 Histopathology was the reference standard.

For diagnostic accuracy, inadequate smears were excluded and suspicious and positive smears were considered test-positive. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy were calculated with 95% confidence intervals, and a receiver operating characteristic (ROC) curve was constructed treating the cytology categories as an ordinal scale. The chi-square test was used for associations, with $p < 0.05$ considered significant. Data were entered in Microsoft Excel and analysed using [statistical software and version].

Results

Patients were aged 26–56 years (mean 41.6 ± 8.6 years), and the 41–50 years group was the largest (36.25%). Benign lesions predominated below 40 years and malignant lesions above 40 years ($\chi^2 = 45.42$, $p < 0.001$) [Table 1]. On imprint cytology, 39 smears (48.75%) were negative, 31 (38.75%) positive, 7 (8.75%) suspicious and 3 (3.75%) inadequate [Table 2]. Histopathology showed 43 benign (53.75%) and 37 malignant (46.25%) lesions, with fibroadenoma (53.49%) and invasive breast carcinoma NOS (ductal) (81.08%) as the commonest benign and malignant lesions [Table 3].

Table 1: Age-wise Distribution of Breast Lesions (n = 80)

Age (years)	Benign, n (%)	Malignant, n (%)	Total, n (%)
21–30	10 (90.91)	1 (9.09)	11 (13.75)
31–40	24 (96.00)	1 (4.00)	25 (31.25)
41–50	8 (27.59)	21 (72.41)	29 (36.25)
51–60	1 (6.67)	14 (93.33)	15 (18.75)
Total	43 (53.75)	37 (46.25)	80 (100)

$\chi^2 = 45.42$, $p < 0.001$. Row percentages for benign and malignant.

Table 2: Imprint Cytology Findings (n = 80)

Category	n (%)
Inadequate	3 (3.75)
Negative for malignancy	39 (48.75)
Suspicious for malignancy	7 (8.75)
Positive for malignancy	31 (38.75)
Total	80 (100)

Table 3: Histopathological Spectrum of Breast Lesions (n = 80)

Benign lesion (n = 43)	n (%)	Malignant lesion (n = 37)	n (%)
Fibroadenoma	23 (53.49)	Invasive carcinoma NOS (ductal)	30 (81.08)
Fibrocystic disease	11 (25.58)	Invasive lobular carcinoma	5 (13.51)
Inflammatory lesion	3 (6.98)	Medullary carcinoma	1 (2.70)
Phyllodes tumour, benign	2 (4.65)	Mucinous carcinoma	1 (2.70)
Fat necrosis, papilloma, adenosis, duct ectasia	1 each (2.33)		

Of the 39 negative smears, 38 (97.44%) were benign on histopathology, and of the 31 positive smears, 30 (96.77%) were malignant. The seven suspicious smears comprised four malignant and three benign lesions (two fibrocystic disease, one fibroadenoma) [Table 4]. After excluding the three inadequate smears, 77 cases were analysed: 34 true positives, 38 true negatives, 4 false positives and 1 false negative [Table 5]. Diagnostic accuracy parameters are shown in [Table 6]; the area under the ROC curve was 0.967.

Table 4: Correlation of Imprint Cytology with Histopathology (n = 80)

Imprint cytology	HPE: benign	HPE: malignant	Total
Inadequate	1	2	3
Negative for malignancy	38	1	39
Suspicious for malignancy	3	4	7
Positive for malignancy	1	30	31
Total	43	37	80

$\chi^2 = 62.25$, df = 2, $p < 0.001$ (inadequate smears excluded). HPE: histopathology.

Table 5: 2 × 2 Table of Imprint Cytology vs Histopathology (n = 77)

Imprint cytology	HPE: malignant	HPE: benign	Total
Positive*	34 (TP)	4 (FP)	38
Negative	1 (FN)	38 (TN)	39
Total	35	42	77

*Suspicious + positive for malignancy. TP/FP: true/false positive; FN/TN: false/true negative.

Table 6: Diagnostic Accuracy of Imprint Cytology (n = 77)

Parameter	Value	95% CI
Sensitivity	97.14%	85.08–99.93
Specificity	90.48%	77.38–97.34
PPV	89.47%	75.70–96.65
NPV	97.44%	86.52–99.94
Accuracy	93.51%	85.54–97.88
AUC (ROC)	0.967	0.927–1.000

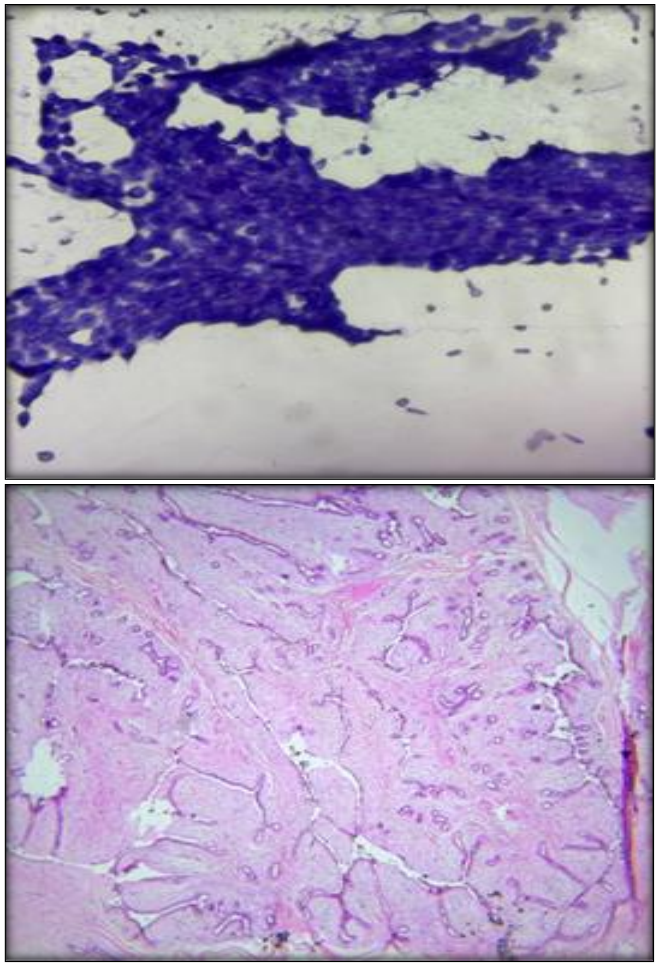


Figure 1: Fibroadenoma. (a) Imprint smear showing cohesive clusters of benign ductal epithelial cells (H&E, 40x). (b) Histopathology showing compressed, slit-like ducts in proliferating stroma (H&E, 40x).

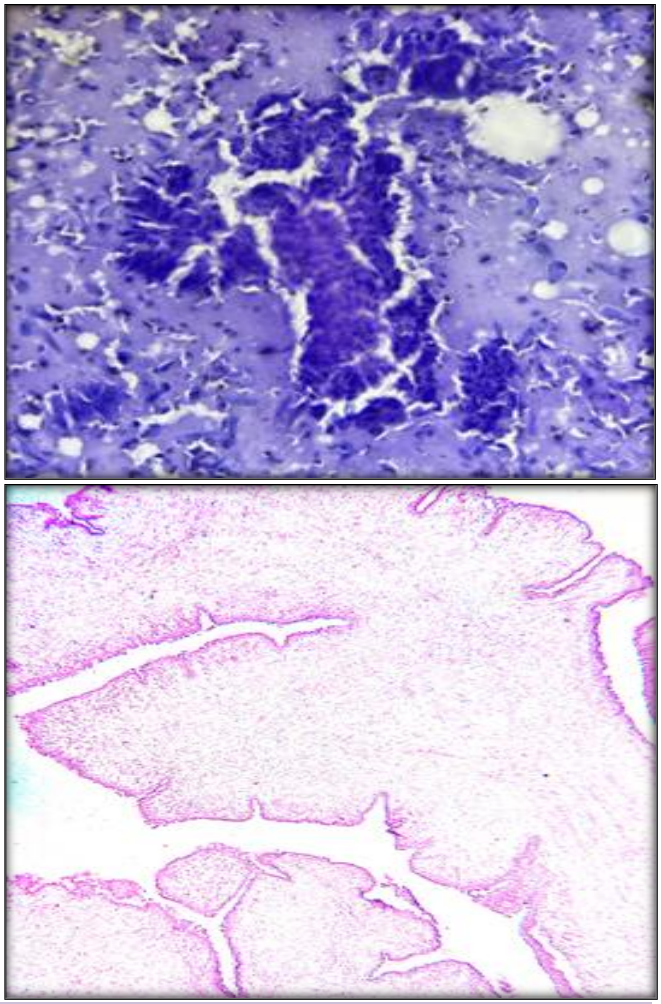


Figure 2: Benign Phyllodes Tumour. (a) Imprint smear (H&E, 40x). (b) Histopathology showing leaf-like architecture (H&E, 40x).

Table 7: Comparison of Diagnostic Accuracy of Imprint Cytology with Other Studies

Study	Specimen	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Present study (n = 80)	Breast lesions	97.14	90.48	89.47	97.44	93.51
Mahadevappa et al. (2017)4	Breast lesions	100	96.43	97.06	100	98.36
Akhtar et al. (2010)5*	Breast lesions	100	71	86	100	85.5
Safai et al. (2012)12	Sentinel nodes	90	100	100	–	–
Richards et al. (2013)13	Sentinel nodes	88	100	100	–	–
Pétursson et al. (2018)14	Sentinel nodes	58.6	99.7	–	–	–
Abe et al. (2020)15	Sentinel nodes	61.5	100	–	–	–

*Touch imprints, atypical smears considered positive. –: not reported.

Sentinel lymph node studies report near-perfect specificity but lower sensitivity (58.6–90%),[12-15] because micrometastases are easily missed in scanty nodal imprints; primary breast lesions yield more cellular smears, which likely explains our higher sensitivity. Cellular yield also falls after neoadjuvant chemotherapy,[16] and imprints of core biopsies

show high concordance with histology.[17-19] Treating cytology categories as an ordinal scale, the AUC of 0.967 confirms excellent discrimination, supporting imprint cytology as a rapid adjunct where frozen section is unavailable.[4,19] The limitations of this study are its single-centre design, modest sample size, and the absence of frozen section comparison, interobserver assessment and immunocytochemistry.

Discussion

Most lesions in the present study occurred in the 41–50 years age group, and malignancy rose significantly with age. Mahadevappa et al. similarly found breast lesions most frequent in the fourth decade, with fibroadenoma (42.86% of benign neoplasms) and infiltrating duct carcinoma (75.76% of malignancies) as the commonest lesions, a spectrum comparable to ours.[4] The near-equal proportion of benign and malignant lesions in our series provided a balanced basis for assessing diagnostic performance.

Only 3.75% of smears were inadequate, close to the 1.61% of Mahadevappa et al,[4] and lower than the 13% reported by Raj et al. in radiologically indeterminate lesions.[11] The suspicious category (8.75%) contained both malignant and benign lesions, the latter being fibrocystic disease and fibroadenoma; it reflects the cytological grey zone of proliferative lesions and should prompt deferral to histopathology rather than definitive surgery.

Imprint cytology showed a sensitivity of 97.14%, specificity of 90.48% and accuracy of 93.51%, comparable to other studies of primary breast lesions [Table 7]. Mahadevappa et al. reported a sensitivity of 100%, specificity of 96.43% and accuracy of 98.36%.[4] Akhtar et al. found that specificity fell from 100% to 71% when atypical smears were counted as positive.[5] and our lower specificity is similarly explained: three of the four false positives came from the suspicious category. Highly cellular benign lesions such as cellular fibroadenoma and proliferative lesions with atypia are recognised causes of false positives, while sclerotic, lobular, low-grade and mucinous tumours may yield false negatives.[4] Our single false negative was an invasive carcinoma NOS (ductal), and the high NPV (97.44%) shows that a negative imprint is reliable for excluding malignancy.

Conclusion

Imprint cytology is a simple, rapid, cost-effective and tissue-preserving technique with high sensitivity, specificity and accuracy for differentiating benign from malignant breast lesions. A negative imprint reliably excludes malignancy, while suspicious smears should be deferred to histopathology, which remains indispensable for definitive diagnosis, typing and grading.

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Conflicts of interest

There are no conflicts of interest.

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