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RESEARCH ARTICLE

CORRELATION OF BREAST ULTRASOUND AND MAMMOGRAPHY WITH TRU-CUT & CORE NEEDLE BIOPSY IN THE DIAGNOSIS OF BREAST PATHOLOGIES

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Abstract: ***Background:*** Accurate preoperative characterization of breast lesions relies on imaging; however, the diagnostic yield of individual modalities varies. This study evaluated ultrasonography (USG), mammography (MMG), and their combination against histopathology. ***Methods:*** In a cross-sectional study of women with imaging-suspicious breast lesions (n=53), both USG and MMG were reported using BI-RADS, and all indicated cases underwent tru-cut/core biopsy (reference standard). Diagnostic performance (sensitivity, accuracy) was calculated for USG, MMG, and combined USG+MMG. ***Results:*** Age distribution was 18–20 (3.8%), 21–30 (30.2%), 31–40 (26.4%), 41–50 (24.5%), 51–60 (9.4%), and 61–70 years (5.7%). BI-RADS categories were: 3 (58.5%), 4 (7.5%), 5 (30.2%), and 6 (3.8%). Final histopathology (HPE) showed invasive ductal carcinoma (IDC) 33.9% (18/53), fibroadenoma 30.2% (16/53), fibrocystic disease 15.1% (8/53), phyllodes 11.3% (6/53), intraductal papilloma 7.5% (4/53), and acute inflammatory lesion 1.9% (1/53). USG demonstrated sensitivity 88.9% and accuracy 90.57%; MMG showed sensitivity 83.3% and accuracy 84.91%. The combined USG+MMG approach yielded the highest performance with sensitivity 94.4% and accuracy 95.62%. ***Conclusion:*** In this cohort, combined USG and mammography outperformed either modality alone for detecting biopsy-proven breast pathology, achieving the highest sensitivity and accuracy. These findings support a complementary, dual-modality approach for symptomatic or high-risk patients in routine practice.

Keywords: Breast imaging; BI-RADS; Ultrasonography; Mammography; Histopathology; Diagnostic accuracy.

INTRODUCTION

Breast cancer remains the most commonly diagnosed malignancy among women worldwide, with an estimated 2.3 million new cases in 2022, underscoring the need for accurate, accessible diagnostic pathways across screening and symptomatic settings [1]. Imaging is central to this pathway; over the past two decades, technique refinements and modality integration have progressively improved lesion detection and characterization [2].

Population-level data demonstrate that organized mammographic screening reduces breast cancer mortality, and technical progress from film to digital systems has yielded measurable diagnostic gains, particularly in image acquisition and interpretation workflows [3,4]. Yet screening performance is not uniform: outcomes vary by screening interval, breast density, and hormone therapy exposure, with density especially diminishing mammographic conspicuity and prompting consideration of adjunct imaging in selected subgroups [5,6].

Within this landscape, ultrasonography (USG) and mammography (MMG) are complementary. Mammography offers high spatial resolution and calcification detection, while ultrasound better depicts mass morphology and guides tissue sampling—particularly useful in dense breasts and symptomatic clinics [2]. However, real-world diagnostic yield depends on how these modalities are used together, the population evaluated (screening vs symptomatic), and the rigor of histopathology correlation.

Against this background, we evaluated the diagnostic performance of USG, MMG, and their combined use in women with imaging-suspicious breast lesions, using histopathology as the reference standard. Our objectives were to (i) describe cohort characteristics and imaging categorization, (ii) compare provisional USG/MMG diagnoses with final pathology, and (iii) quantify sensitivity and overall accuracy for each approach—thereby informing pragmatic, dual-modality workflows in symptomatic care [1–6]

MATERIAL AND METHODS

Study design and setting

This was a single-centre, cross-sectional observational study conducted over one academic year in the Department of Radiology at a tertiary teaching hospital (Parul University, Vadodara, India). All imaging and reporting followed departmental protocols.

Participants

Target population. Women evaluated for breast lesions with both ultrasonography (USG) and mammography (MMG) during the study period.

Inclusion criteria.

1. Female patients who underwent USG and MMG for evaluation of a breast lesion;
2. Imaging categorized using BI-RADS;
3. Availability of histopathology (tru-cut/core needle biopsy) for lesions indicated for biopsy by imaging (i.e., BI-RADS 4–5) and for known malignancy (BI-RADS 6).

Exclusion criteria.

1. Cases without histopathology correlation for lesions that required biopsy (i.e., missing reference standard);
2. Incomplete records precluding accurate extraction of imaging category or final pathology.

The final analytic cohort comprised 53 women.

Imaging acquisition and reporting

- Mammography (MMG): Performed on a MAM-VENUS unit. Standard departmental acquisition was used; reports documented BI-RADS category and a provisional diagnostic label (e.g., invasive ductal carcinoma, fibroadenoma).
- Ultrasonography (USG): Performed on Mindray DC-70 / DC-60 and Canon Xario 200 systems with a high-frequency linear probe; Doppler applied when indicated. USG reports similarly included BI-RADS category and a provisional diagnostic label.
- BI-RADS framework: BI-RADS 3–6 categories were recorded. Per institutional practice, BI-RADS 4–5 underwent biopsy; BI-RADS 6 denoted known malignancy.

Reference standard (histopathology)

The reference standard was tru-cut/core needle biopsy with routine histopathological examination. Final pathology categories included invasive ductal carcinoma (IDC), fibroadenoma, fibrocystic disease, phyllodes tumour, intraductal papilloma, and acute inflammatory lesions.

Outcomes. The primary outcome was diagnostic sensitivity and overall accuracy of ultrasonography (USG), mammography (MMG), and their combined use (USG+MMG) against histopathology. Descriptive outcomes included cohort characteristics (age bands, indication for imaging, family history, nipple retraction), BI-RADS distribution, and provisional imaging diagnoses on USG and MMG compared with the final histopathology spectrum.

Data handling and analysis. All variables were abstracted from the study dataset. Accuracy metrics are reported exactly as available: USG—sensitivity 88.9% and accuracy 90.57%; MMG—sensitivity 83.3% and accuracy 84.91%; combined USG+MMG—sensitivity 94.4% and accuracy 95.62%. Counts for TP/FP/TN/FN, specificity, predictive values, and confidence intervals were not available and are therefore not presented. Descriptive results are shown as n (%) with a denominator of n = 53.

Equipment. Mammography was performed on a MAM-VENUS unit. Ultrasound examinations were performed on Mindray DC-70/DC-60 and Canon Xario 200 systems using a high-frequency linear probe, with Doppler applied when indicated. All imaging and reporting followed departmental protocols during the study period.

RESULTS AND OBSERVATIONS:

A total of 53 women with imaging-suspicious breast lesions underwent evaluation with ultrasonography (USG) and mammography (MMG), each reported using BI-RADS, followed by tru-cut/core biopsy as the reference standard. We summarize the cohort profile, BI-RADS categorization, provisional imaging diagnoses, the histopathology spectrum, and the diagnostic performance of USG, MMG, and their combined use against histopathology. As previewed, the combined modality yielded the highest sensitivity and overall accuracy in this series.

Baseline characteristics of the cohort

Among 53 women, most were in the 21–30 years (30.2%) and 31–40 years (26.4%) age bands, followed by 41–50 years (24.5%). Mammography was performed chiefly for a palpable lump (60.4%), with the remainder obtained for screening/asymptomatic indications (39.6%). A family history of breast cancer was documented in 15.1%. On clinical examination, nipple retraction was present in 43.4% (23/53).

Imaging categorization (BI-RADS)

Across the cohort (n = 53), BI-RADS categories were: BI-RADS 3: 58.5%, BI-RADS 4: 7.5%, BI-RADS 5: 30.2%, and BI-RADS 6: 3.8%. Per institutional practice, all BI-RADS 4–5 lesions underwent biopsy, while BI-RADS 6 denoted known malignancy.

Table 1. Baseline characteristics (n = 53)

Variable	Category	n (%)
Age (years)	18–20	2 (3.8)
	21–30	16 (30.2)
	31–40	14 (26.4)
	41–50	13 (24.5)
	51–60	5 (9.4)
	61–70	3 (5.7)
Indication for mammography	Palpable lump	32 (60.4)
	Screening/asymptomatic	21 (39.6)
Family history of breast cancer	Yes	8 (15.1)
	No	45 (84.9)
Clinical sign	Nipple retraction present	23 (43.4)
	Nipple retraction absent	30 (56.6)

Values are n (%); percentages are calculated over n = 53 and align with the reported values.

Imaging categorization (BI-RADS)

Across the cohort (n = 53), BI-RADS categories were: BI-RADS 3: 58.5%, BI-RADS 4: 7.5%, BI-RADS 5: 30.2%, and BI-RADS 6: 3.8%. Per institutional practice, all BI-RADS 4–5 lesions underwent biopsy, while BI-RADS 6 denoted known malignancy.

Table 2. BI-RADS categories (n = 53)

BI-RADS Category	n (%)
3	31 (58.5)
4	4 (7.5)
5	16 (30.2)
6	2 (3.8)

Footnote: Values are n (%); percentages are calculated over n = 53.

Provisional imaging diagnoses before biopsy

Before histopathological confirmation, provisional diagnoses were assigned on ultrasonography (USG) and mammography (MMG). On USG, the most frequent labels were invasive ductal carcinoma (IDC) and fibroadenoma, followed by fibrocystic disease, phyllodes, intraductal papilloma, acute inflammatory lesion, and a small group deemed suspicious/indeterminate. MMG showed a similar pattern, with IDC and fibroadenoma most common.

Table 3. Provisional diagnoses by modality (USG vs MMG), n = 53 each

Diagnosis	USG n (%)	MMG n (%)
Invasive ductal carcinoma (IDC)	16 (30.2)	15 (28.3)
Fibroadenoma	15 (28.3)	14 (26.4)
Fibrocystic disease	6 (11.3)	6 (11.3)
Phyllodes	6 (11.3)	6 (11.3)
Intraductal papilloma	4 (7.5)	3 (5.6)
Acute inflammatory lesion	1 (1.9)	1 (1.9)
Suspicious/indeterminate	5 (9.4)	8 (15.1)

Percentages are calculated out of n = 53 per modality.

Histopathology spectrum (reference standard)

On final histopathological examination (n = 53), the most common diagnosis was invasive ductal carcinoma (IDC), followed by fibroadenoma, fibrocystic disease, phyllodes, intraductal papilloma, and a small number of acute inflammatory lesions.

Table 4. Final histopathology diagnoses (n = 53)

Diagnosis	n	%
Invasive ductal carcinoma (IDC)	18	33.9
Fibroadenoma	16	30.2
Fibrocystic disease	8	15.1
Phyllodes	6	11.3
Intraductal papilloma	4	7.5
Acute inflammatory lesion	1	1.9

Percentages are calculated out of n = 53.

Diagnostic performance versus histopathology (primary outcomes)

Against the histopathological reference, USG achieved a sensitivity of 88.9% and an accuracy of 90.57%. Mammography (MMG) showed sensitivity 83.3% and accuracy 84.91%. The combined USG+MMG approach yielded the highest values, with sensitivity 94.4% and accuracy 95.62%. Counts for TP/FP/TN/FN, as well as specificity, PPV/NPV, and confidence intervals, were not available in the study dataset and are not presented.

Table 5. Diagnostic performance vs histopathology

Modality	Sensitivity (%)	Accuracy (%)
USG	88.9	90.57
Mammography (MMG)	83.3	84.91
Combined (USG + MMG)	94.4	95.62

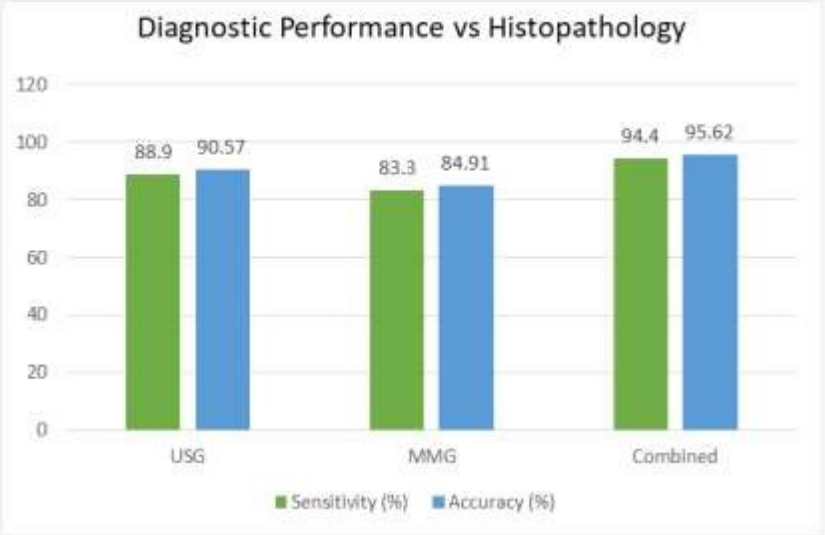

Figure 1. Comparative performance of ultrasonography (USG), mammography (MMG), and the combined approach against histopathology. Bars show sensitivity and overall accuracy (percent).

Comparative diagnostic pattern across modalities vs HPE

To visualize how provisional imaging labels compare with the reference standard, we plotted grouped bars for each diagnostic category—IDC, fibroadenoma, fibrocystic disease, phyllodes, intraductal papilloma, and acute inflammatory—showing USG, MMG, and final HPE counts side by side. This highlights areas of over- or under-calling by each modality relative to histopathology, adding diagnostic nuance beyond aggregate accuracy metrics.

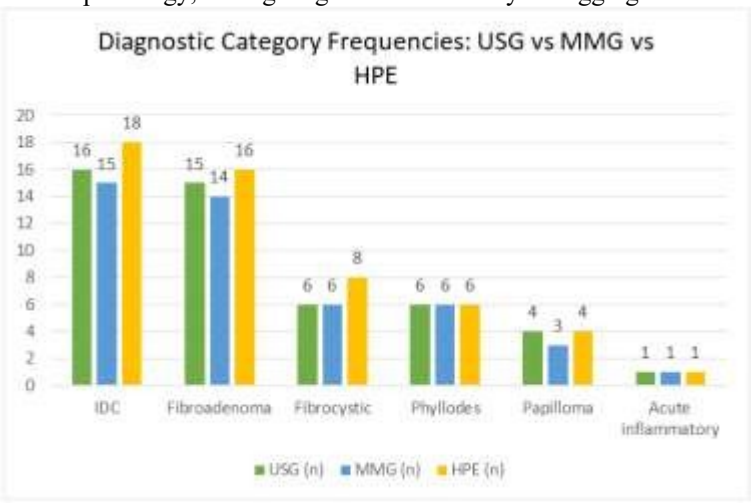

Figure 2. Grouped counts (n) of IDC, fibroadenoma, fibrocystic disease, phyllodes, intraductal papilloma, and acute inflammatory lesions on ultrasonography (USG) and mammography (MMG) compared with final histopathology (n = 53)

In this cohort, the combined USG+MMG approach achieved the highest diagnostic performance, with sensitivity 94.4% and accuracy 95.62%, outperforming either modality alone. These results support a complementary, dual-modality strategy for evaluating imaging-suspicious breast lesions and frame the clinical implications.

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DISCUSSION

Our findings show that pairing ultrasonography (USG) with mammography (MMG) improves detection relative to either test alone—consistent with the broader accuracy literature. In a hospital-based series, Fatima et al. (2019) reported high diagnostic performance when imaging was judged against histopathology, underscoring that imaging–pathology correlation remains the appropriate benchmark for clinical decision-making [7]. Although their modality emphasis was MR mammography rather than USG/MMG, their core result—high sensitivity with acceptable overall accuracy when validated against tissue—aligns with our approach of treating histopathology as the reference standard and helps contextualize our combined sensitivity of 94.4% and accuracy of 95.62%.

Synthesizing multiple cohorts, Tadesse et al. (2023) found that USG and MMG each perform well but with complementary strengths; pooled estimates in their meta-analysis typically place MMG sensitivity in the ~0.80–0.85 range and USG sensitivity in the ~0.85–0.90 range, with combined strategies achieving the highest yield [8]. This mirrors our pattern, where USG (88.9%) slightly outperformed MMG (83.3%), and the combined read achieved the best performance.

Category assignment also matters. In MRI cohorts, Chikarmane et al. (2017) showed that BI-RADS 3 carries a low malignancy probability (often <2–3%), BI-RADS 4 a wide but intermediate risk, and BI-RADS 5 a high likelihood of cancer (commonly >90%) [9]. While our modality is different, the principle generalizes: a biopsy-driven approach for BI-RADS 4–5 is justified, and our distribution (BI-RADS 3: 58.5%; 4: 7.5%; 5: 30.2%; 6: 3.8%) is congruent with selectively intervening in higher-risk categories.

Population factors influence test yield. Sprague et al. (2015) quantified how dense breasts attenuate MMG sensitivity and showed that supplemental USG can detect roughly 3–4 additional cancers per 1,000 screens at the cost of more false positives [10]. Our cohort's higher combined sensitivity is consistent with that complementarity, particularly in settings where density and age skew toward reduced mammographic conspicuity. In symptomatic pathways, Devolli-Disha et al. (2009) reported that USG can outperform MMG in younger/dense breasts, whereas MMG remains strong in older/fatty breasts, a pattern that helps explain our modality-specific results and supports using both tools in symptomatic evaluation [11].

Downstream confirmation is essential. Classic data from Minkowitz et al. (1986) demonstrated that tru-cut/core needle biopsy provides high diagnostic fidelity—sensitivities around the high-80s to low-90s and specificities approaching ~100% in many series—thereby validating imaging impressions and anchoring management [12]. Their emphasis on tissue diagnosis applies across entities; for example, invasive ductal carcinoma (IDC) is robustly confirmed on core biopsy with high agreement to final surgical pathology in most reports, reinforcing our reliance on histopathology to adjudicate imaging calls [12].

At the evidence-synthesis level, Tadesse et al. (2023) again concluded that dual-modality strategies generally outperform single modalities in pooled analyses, especially when readers integrate concordant signs (e.g., spiculated mass on MMG plus suspicious echotexture on USG) [13]. Regionally, practice patterns also shape outcomes. The Breast Imaging Society–India guidance (Chakrabarthi et al., 2022) endorses pragmatic combinations of MMG and USG, particularly in dense breasts and symptomatic clinics, and stresses context-specific workflows—recommendations that line up with our combined-modality advantage and pathway design [14].

Finally, transparent reporting is critical. The STARD 2015 framework (Cohen et al., 2016) recommends clear specification of reference standards and complete accounting of accuracy metrics [15]. Our dataset reports sensitivity and accuracy but lacks TP/FP/TN/FN counts, specificity, predictive values, and confidence intervals—an acknowledged limitation. Even so, the observed magnitudes fall within plausible ranges from multi-study summaries (e.g., USG ≈85–90%, MMG ≈80–85%, combined modestly higher), and our histology-anchored approach aligns with best-practice reporting, while inviting future work with fuller 2×2 data and precision estimates.

Not all series show a large incremental gain from combination. Some screening-dominant studies report only modest sensitivity upticks with USG added to MMG (e.g., +2–5%), coupled with more recalls and benign biopsies [10]. Differences in population (screening vs symptomatic), age/density mix, lesion spectrum (e.g., proportion of subtle DCIS vs mass-forming IDC), and reader expertise plausibly account for variation across reports [8–11,14,15]. Our symptomatic cohort—with a substantial fraction of BI-RADS 5 and a histology spectrum led by IDC (33.9%)—is well-positioned to benefit from dual-modality imaging, which matches the direction of effect noted in meta-analytic and guideline sources [8,14,14]. In sum, our combined USG+MMG sensitivity (94.4%) and accuracy (95.62%) are directionally consistent with multi-study evidence that the modalities are complementary. The literature supports using tissue diagnosis as the arbiter [7,12,13], leveraging category-based risk to guide biopsy [9], tailoring adjunct imaging in dense or symptomatic settings [10,11,15], and reporting accuracy transparently per STARD [15]. Future work should extend these findings with complete

diagnostic 2×2 data, stratified by age/density and lesion subtype, to refine estimates and improve generalizability.

Limitations

This single-centre, cross-sectional study included a modest cohort (n = 53) and reported only sensitivity and overall accuracy, without TP/FP/TN/FN counts, specificity, predictive values, or confidence intervals. Interobserver variability was not assessed, and selection within a symptomatic pathway may limit generalizability.

CONCLUSION

In women with imaging-suspicious breast lesions, combining USG+MMG yielded the highest diagnostic performance (sensitivity 94.4%, accuracy 95.62%), outperforming either USG (88.9%, 90.57%) or MMG (83.3%, 84.91%) alone. These findings support a complementary, dual-modality strategy for routine evaluation, particularly in symptomatic settings. Larger, multicentre studies with complete 2×2 data, precision estimates, and stratification by age/density are warranted to refine effect sizes and enhance external validity.

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