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Enhancing Diagnostic Accuracy in Symptomatic Breast Diseases: The Role of Ultrasound with Mammography

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Author`s Contribution

[1,2]Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work, [4,5]Active participation in active methodology, [3,5]Drafting the work or revising it critically for important intellectual content, [6]Final approval

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ABSTRACT

Objectives: To evaluate the diagnostic performance of mammography and ultrasound, individually and in combination, in patients presenting with symptomatic breast disease.

Methodology: A cross-sectional validation study was conducted in the Department of Surgery at a PAF hospital in Islamabad, affiliated with Air University, from January 2025 to August 2025. A total of 120 female patients with breast symptoms underwent standard two-view mammography and targeted breast ultrasound. Imaging findings were categorized using the BI-RADS classification and correlated with histopathology, which served as the gold standard. Diagnostic parameters, including sensitivity, specificity, predictive values, and overall accuracy, were calculated.

Results: The mean age of the patients was 44.2 ± 10.8 years, with the majority belonging to the 41–50-year age group. Mammography demonstrated a sensitivity of 76.2% and a specificity of 79.5%, while ultrasound showed a sensitivity of 90.5% and a specificity of 85.9%. When both modalities were combined, sensitivity increased to 95.2%, specificity to 91.0%, and overall diagnostic accuracy to 92.5%. The negative predictive value was highest for the combined approach (97.3%), thereby minimizing false-negative results.

Conclusion: The combination of ultrasound with mammography significantly improves diagnostic accuracy in symptomatic breast disease compared with either modality alone and should be incorporated into routine clinical practice.

Keywords: Accuracy, Breast cancer, Mammography, Symptomatic breast disease, Ultrasound

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Introduction

Breast disorders, particularly breast cancer, remain a major global health challenge, accounting for substantial morbidity and mortality among women. Globally, breast cancer is the most common malignancy in women, representing approximately one in four cancer cases and nearly 2.3 million new diagnoses annually.[1] In Pakistan, it has the highest incidence among women and one of the highest prevalence rates in Asia, with nearly one in nine women at risk during her lifetime.[2] Accurate and timely diagnosis plays a pivotal role in improving patient outcomes. Imaging is central to this process, and although mammography has long been the standard modality for both screening and diagnosis, it is not without limitations.[3] In symptomatic patients—those presenting with palpable lumps, pain, or other clinical signs—exclusive reliance on mammography may compromise diagnostic accuracy. This has led to the increasing adoption of ultrasound as a valuable complementary imaging modality.[4]

Mammography works on x-ray attenuation differences offers distinct advantages, most notably in detecting calcifications and subtle architectural distortions that may indicate early malignancy. It is particularly effective in population-level screening and in uncovering lesions that may not be clinically apparent.[5] However, its diagnostic performance declines in younger women and in those with dense breast tissue, where overlapping structures often mask abnormalities. This reduced sensitivity not only raises the risk of false negatives but can also increase patient anxiety and delay appropriate care.[6]

Ultrasound works on sound wave reflection addresses many of these shortcomings by providing real-time imaging that is not affected by breast density. It is particularly useful in distinguishing cystic from solid lesions and in assessing features such as margins, echogenicity, and vascular patterns. Beyond diagnosis, ultrasound also serves a procedural role, guiding biopsies and aspirations with precision. Its accessibility, safety, and absence of radiation further strengthen its place in the diagnostic pathway.[7,8] When used alongside mammography, ultrasound has been shown to significantly improve detection rates and reduce diagnostic uncertainty. Moreover, this dual-modality approach not only detects malignancies but also provides reliable characterization of lesions as benign or malignant, improving overall diagnostic confidence.[9] BI-RADS lesion categorizes the breast findings into seven categories ranging from 0 to 6. Category 0 is labeled as inconclusive and needs additional imaging, category 1 as normal, category 2 as benign, category 3 as probably benign, category 4 as probably malignant, category 5 as malignant, and category 6 as biopsy-proven malignant. Literature reviews shows that combining more than one modality has significant impact on sensitivity in diagnosing breast lumps as shown in study by Anoop Kumar Nair et al. in which ultrasound sensitivity was 78.04%, Mammography 80.48%, MRI 100% and combined sensitivity was 86.17%.[10]

In resourse-limited healthcare settings, particularly where advanced technologies such as MRI are limited, the combination of mammography and ultrasound offers a practical, cost-effective solution. It leverages the complementary strengths of both methods: mammography's ability to capture calcifications and broad structural changes, and ultrasound's detailed assessment of tissue characteristics and lesion morphology. Together, they create a more reliable diagnostic framework that enhances patient care, reduces errors, and promotes early intervention. This article explores the role of ultrasound as an adjunct to mammography in evaluating symptomatic breast diseases using BIRADS classification and histopathological correlation. By reviewing current evidence and highlighting the strengths and limitations of each modality, we aim to demonstrate how their integration improves accuracy, optimizes diagnostic pathways, and ultimately benefits patient outcomes.[10]

Methodology

This cross-sectional validation study was conducted on 120 female patients who presented with symptomatic breast complaints, including palpable lumps, breast pain, and nipple discharge, at the Surgery department of our institution. Patients were enrolled after obtaining informed consent, and ethical clearance was secured from the institutional review board (LM NO IH/76027/6/Med). The inclusion criteria were women above 20 years of age who presented with clinically significant breast symptoms and were referred for imaging evaluation. Patients with a prior history of breast surgery, previous malignancy, or incomplete imaging records and whose histopathology report could not be traced were excluded from the study. The sample size was calculated based on a confidence interval of 95% and a margin of error of 5% and taking the number of lesions correctly diagnosed by combined mammography and ultrasound which yielded 120 patients.[11] The sensitivity, specificity, Positive predictive value (PPV) and Negative Predictive value (NPV) of mammography in detecting Carcinoma breast are 77.77%, 97.72%, 87.5% and 95.55% respectively. The sensitivity, specificity, PPV and NPV of Ultrasound in detecting Carcinoma breast are 55.55%, 97.72%, 83.33% and 91.48% respectively.[11]

Each patient underwent a standard two-view digital mammography examination, which included craniocaudal (CC) and mediolateral oblique (MLO) views. Mammographic images were evaluated for the presence of masses, microcalcifications, architectural distortions, and asymmetries. Breast density was also classified according to the American College of Radiology Breast Imaging Reporting and Data System (BI-RADS) categories. Following mammography, all patients were subjected to targeted breast ultrasound using a high-frequency linear transducer. Ultrasound evaluation was performed in the symptomatic breast and, when required, in the contralateral breast. Lesions were assessed for shape, margins, echogenicity, posterior acoustic features, and vascularity using color Doppler when appropriate.

Both imaging modalities were interpreted independently and then correlated. Each lesion was categorized according to the BI-RADS classification system, and diagnostic concordance between mammography and ultrasound was analyzed. BI-RADS category was assigned after each scan from 1 to 5. BI-RADS categories 1, 2, and 3 were considered negative (benign), while BI-RADS category 4 (probably malignant) and 5 was considered positive (Malignant). In all cases ultrasound-guided biopsy was performed for histopathological confirmation, which was considered the reference standard. Histopathological findings were labeled as benign or malignant.

Data was compiled and analyzed using appropriate statistical software. Sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy were calculated for mammography and ultrasound, both separately and in combination. Comparative analysis was performed to determine the incremental value of ultrasound when added to mammography in the evaluation of symptomatic breast diseases.

Results

The demographic profile of the study population revealed a mean age of 44.2 ± 10.8 years (range: 22–72). Most patients were in the 41–50 years group (31.7%), followed by 31–40 years (26.7%). More than half of the women were premenopausal (56.7%), while 43.3% were postmenopausal. The majority of patients were multiparous (76.7%), and only 23.3% were nulliparous. Regarding laterality, right-sided breast symptoms were more common (53.3%) than left-sided (41.7%), with only 5% presenting bilaterally. A family history of breast cancer was present in 15% of cases. The mean BMI was 26.8 ± 4.5 kg/m², placing most patients in the overweight category, as given in Table I.

Table I: Demographic and Clinical Characteristics of Patients. (n = 120)

Variable	Value
Age (years)	44.2 ± 10.8 (range: 22–72)
Age Group	
21–30	18 (15.0)
31–40	32 (26.7)
41–50	38 (31.7)
51–60	22 (18.3)
>60	10 (8.3)
Menopausal Status	
Premenopausal	68 (56.7)
Postmenopausal	52 (43.3)
Parity	
Nulliparous	28 (23.3)
Multiparous	92 (76.7)
Breast Laterality of Symptom	
Right	64 (53.3)
Left	50 (41.7)
Bilateral	6 (5.0)
Family History of Breast Cancer	
Present	18 (15.0)
Absent	102 (85.0)
Body Mass Index (BMI, kg/m²)	26.8 ± 4.5 (range: 19–38)

The breast lump was associated with breast pain (18.3%), Nipple discharge was reported in 8.3% of patients, while 6.7% had skin or nipple changes, and 5% presented with multiple other symptoms. In terms of duration, 46.7% of patients had symptoms for 1–6 months, while 35% had symptoms for less than one month. Of the patients with nipple discharge, serous discharge was most frequent (40%), followed by bloody (30%), purulent (20%), and other types (10%), as shown in Table II.

Table II: Clinical Presentations of Patients. (n = 120)

Variable	Number of Patients n (%)
Duration of Symptoms	
≤1 month	42 (35.0)
1–6 months	56 (46.7)
>6 months	22 (18.3)
Type of Nipple Discharge (n = 10)	
Serous	4 (40.0)
Bloody	3 (30.0)
Purulent	2 (20.0)
Others	1 (10.0)

When comparing imaging modalities, mammography detected 60 benign (50%) BIRADS I, II and III and 2 (1.66%) as BIRADS IV, 58 malignant lesions (48.3%) BIRADS V, whereas ultrasound identified 70 benign (58.3%) and 50 malignant (41.7%) cases. These findings demonstrated variability in the diagnostic yield of each modality, as summarized in Table III.

Table III: Imaging Findings Detected by Mammography and Ultrasound .(n = 120)

Imaging Findings	Mammography	Ultrasound
Benign lesions	62 (51.7)	70 (58.3)
Malignant lesions	58 (48.3)	50 (41.7)
Total	120 (100.0)	120 (100.0)

Among 62 patients who were considered benign on mammography, 60 patients were considered benign according to BIRADS I-III and 2 patients were BIRADS.

In the combined evaluation of mammography and ultrasound against histopathology, 40 cases (95.2%) were true positives, while 7 cases (9.0%) were false positives. Conversely, 71 cases (91.0%) were true negatives, and only 2 cases (4.8%) were false negatives. This distribution highlighted the strong diagnostic agreement of combined imaging with the gold standard, as presented in Table IV.

The diagnostic performance analysis of the combined modalities showed a sensitivity of 95.2% and a specificity of 91.0%. The positive predictive value was 85.1%, and the negative predictive value was 97.3%, with an overall diagnostic accuracy of 92.5%. These results demonstrated the high reliability of combining

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mammography with ultrasound in symptomatic breast disease evaluation, as given in Table V.

Table IV: Diagnostic Performance of Combined Mammography and Ultrasound vs. Histopathology. (n = 120)

Parameters	Histopathology Malignant	Histopathology Benign	Total
Imaging Positive (TP / FP)	40 (95.2%) TP	7 (9.0%) FP	47 (39.2%)
Imaging Negative (FN / TN)	2 (4.8%) FN	71 (91.0%) TN	73 (60.8%)
Total	42 (100%)	78 (100%)	120 (100%)

Table V: Diagnostic Accuracy of Combined Mammography and Ultrasound Compared with Histopathology. (n = 120)

Parameter	Formula	Value (n/%)
Sensitivity	TP / (TP + FN) = 40 / 42	95.2%
Specificity	TN / (TN + FP) = 71 / 78	91.0%
Positive Predictive Value	TP / (TP + FP) = 40 / 47	85.1%
Negative Predictive Value	TN / (TN + FN) = 71 / 73	97.3%
Accuracy	(TP + TN) / Total = 111 / 120	92.5%

Considering histopathological findings as gold standard, Mammography demonstrated a sensitivity of 76.2% and specificity of 79.5%, while ultrasound showed sensitivity of 90.5% and specificity of 85.9%. When both modalities were combined, sensitivity increased to 95.2%, specificity to 91.0%, and overall diagnostic accuracy to 92.5%.

Discussion

Breast diseases, particularly breast cancer, remain a major global health concern and are a leading cause of morbidity and mortality among women. Early and accurate diagnosis is essential for effective treatment and improved survival.[12] This cross-sectional study was conducted to evaluate the diagnostic accuracy of mammography and ultrasound, individually and in combination, for detecting and characterizing breast diseases, with correlation to cytopathology. Mammography has long been the standard imaging tool; however, its sensitivity is reduced in dense breast tissue. Ultrasound provides complementary advantages by differentiating solid from cystic lesions and guiding biopsies. The combined use of mammography and ultrasound yields higher diagnostic accuracy, and our study further supports this evidence.[13]

The present study demonstrated that the combination of mammography and ultrasound achieved a sensitivity of 95.2%, specificity of 91.0%, NPV of 97.3%, PPV of 85.1%, and an overall diagnostic accuracy of 92.5% when compared against histopathology. These results highlight that the complementary use of both modalities provides a more robust diagnostic tool for evaluating symptomatic breast diseases than either technique alone. Several regional studies support these results. For example, M. Aqil et al. (2020) reported a combined diagnostic accuracy of 99.1%, with sensitivity of 97.5% and specificity of 91.9%, demonstrating that combining ultrasound with mammography consistently improves diagnostic performance in symptomatic populations.[14]

Our ultrasound results (90.5% sensitivity, 85.9% specificity, 87.5% accuracy) are closely in line with several previous studies. Quratulain et al. (2024) reported ultrasound sensitivity of 91.07%, specificity of 83.57%, and accuracy of 88.11%, findings that almost mirror our outcomes.[16] Similarly, Ahmed et al. (2020) documented ultrasound sensitivity of 94.1%, specificity of 89.3%, and accuracy of 90.7%, which are very close to our observations, particularly with regard to NPV (97.5% in their study vs. 97.3% in ours).[19] Our results also closely match those of Khan et al. (2023), who reported sensitivity of 91.67%, specificity of 83.93%, and diagnostic accuracy of 88.57%, further validating the consistency of ultrasound performance across different settings.[20] Additionally, Gharekhanloo et al. (2018) found ultrasound sensitivity of 93.9% and specificity of 86.5%, again closely related to our findings. Together, these comparisons indicate that ultrasound maintains high diagnostic reliability, particularly in symptomatic populations.[22]

On the other hand, the diagnostic yield of mammography alone in our study (76.2% sensitivity, 79.5% specificity, 78.3% accuracy) was modest. These values are somewhat higher than those reported by Shafiq et al. (2022),[15] who observed sensitivity of 60.7%, specificity of 70.5%, and accuracy of 65%, but lower than those reported by Shaikh et al. (2017), who documented sensitivity of 91.3%, specificity of 87.2%, and accuracy of 90%.[17] The discrepancy may be attributed to case mix, as Shaikh et al. included 65% malignant cases compared to 35% in our study, a factor known to influence sensitivity.[17] Moreover, differences in breast density patterns may also account for variability; mammography is less sensitive in dense breasts, a feature observed in 58.3% of our patients. The overall diagnostic accuracy of combined imaging in our study (92.5%) is closely matching the findings of Manzoor et al. (2021), who reported 92.6%

accuracy, sensitivity of 94.7%, and specificity of 89.6% for sonomammography.[18] These findings reinforce the concept that integration of ultrasound and mammography provides complementary strengths—mammography excels in detecting microcalcifications and architectural distortion, while ultrasound is superior in evaluating soft-tissue characteristics and lesion morphology. Our results are also in line with the outcomes of Majeed et al. (2016), who emphasized the predictive value of BI-RADS categorization, further highlighting the strong correlation between structured imaging assessment and histopathology.[23]

In contrast, Akhund et al. (2023) reported lower ultrasound sensitivity (75%) and mammography sensitivity (65%) than our findings, particularly in older women with dense breasts. The divergence may reflect differences in patient demographics, as their cohort had a higher proportion of elderly patients with denser breast tissue, whereas our study included a relatively younger population (mean age 44.2 ± 10.8 years) with mixed density distribution.[21] This suggests that population characteristics, particularly age and breast density, play a critical role in determining the diagnostic yield of imaging modalities. Collectively, our findings are largely in agreement with contemporary evidence, demonstrating that while ultrasound alone performs better than mammography in symptomatic women, the integration of both modalities provides the most reliable diagnostic accuracy. The high NPV of combined imaging (97.3%) in our study is particularly important, as it minimizes false negatives and increases clinician confidence in excluding malignancy.

The study included a reasonably sized sample of 120 patients, providing adequate statistical power. It used both mammography and ultrasound, allowing direct comparison with histopathology as the gold standard. The design minimized bias by applying standardized BI-RADS classification. However, being a single-center study may limit generalizability. Advanced imaging such as MRI was not included for comparison. Longer-term follow-up was not performed to assess diagnostic outcomes beyond initial detection.

Conclusion

The combined use of mammography and ultrasound significantly improved diagnostic accuracy in symptomatic breast diseases. This approach minimized false results and enhanced confidence in clinical decision-making. It can be recommended as a reliable diagnostic strategy in routine practice.

References

1. Cao W, Chen HD, Yu YW, Li N, Chen WQ. Changing profiles of cancer burden worldwide and in China: a secondary analysis of the global cancer statistics 2020. Chin Med J. 2021;134(7):783–91. https://doi.org/10.1097/CM9.0000000000001474
2. Tufail M, Wu C. Cancer statistics in Pakistan from 1994 to 2021: data from cancer registry. JCO Clin Cancer Inform. 2023;7:e2200142. https://doi.org/10.1200/CCI.22.00142
3. Alharbi TA, Rababa M, Alsuwayl H, Alsubail A, Alenizi WS. Diagnostic challenges and patient safety: the critical role of accuracy—a systematic review. J Multidiscip Healthc. 2025;18:3051–64. https://doi.org/10.2147/JMDH.S512254
4. Chandra M*, Varghese B, Sah A. Mammography and advances. In:* Imaging in management of breast diseases. 2025;16(5):35–78. https://doi.org/10.1007/978-981-97-9847-6_4
5. Ibrahim SE, Mohamed WA, Elnokrashy AF. Beyond masses and calcifications: a review of architectural distortion detection for early breast cancer diagnosis. Benha J Eng Sci Technol. 2025;2(1):126–36. https://doi.org/10.21608/bjest.2025.445862
6. Nicosia L, Gnocchi G, Gorini I, Venturini M, Fontana F, Pesapane F, et al. History of mammography: analysis of breast imaging diagnostic achievements over the last century. Healthcare (Basel). 2023;11(11):1596. https://doi.org/10.3390/healthcare11111596
7. Iacob R, Iacob ER, Stoicescu ER, Ghenciu DM, Cocolea DM, Constantinescu A, et al. Evaluating the role of breast ultrasound in early detection of breast cancer in low- and middle-income countries: a comprehensive narrative review. Bioengineering (Basel). 2024;11(3):262. https://doi.org/10.3390/bioengineering11030262
8. Catalano O, Fusco R, De Muzio F, Simonetti I, Palumbo P, Bruno F, et al. Recent advances in ultrasound breast imaging: from industry to clinical practice. Diagnostics (Basel). 2023;13(5):980. https://doi.org/10.3390/diagnostics13050980
9. Zhou J, Zhang Y, Shi S. Ultrasound elastography: advances and challenges in early detection of breast cancer. Front Oncol.2025;15:1589142. https://doi.org/10.3389/fonc.2025.1589142
10. Nair AK, Mishra A, Nath AK. Evaluation, correlation and comparison of role of digital mammography, ultrasonography and MRI in breast imaging. Int J Acad Med Pharm. 2023;5(4):426–35. https://doi.org/10.47009/jamp.2023.5.4.86
11. Tiwari PK, Suvendu G, Agrawal VK. Diagnostic accuracy of mammography and ultrasonography in assessment of breast cancer. Int J Contemp Med Res. 2017;4(1):81–3.
12. Wilkinson L, Gathani T. Understanding breast cancer as a global health concern. Br J Radiol. 2022;95(1130):20211033. https://doi.org/10.1259/bjr.20211033

13. Barrios CH. Global challenges in breast cancer detection and treatment. Breast. 2022;62:S3–6. https://doi.org/10.1016/j.breast.2022.02.003
14. Aqil M, Azmatullah U, Nasir S, Khan AA, Shehbaz L. Diagnostic accuracy of sonomammography in carcinoma breast using biopsy as the gold standard in pre-operative cases. Pak J Surg. 2020;36(1):15–19.
15. Shafiq M, Shamshad L, Ahmed N, Saleem S, Shahid R, Mazhar MA. Diagnostic accuracy of mammography versus ultrasound in prediction of malignancy with palpable breast lesion. Pak J Med Dent. 2022;11(3):11–6.
16. Quratulain S, Bibi S, Gul S, Khatoon S, Mahmood H, Sadia H. Diagnostic accuracy of conventional breast ultrasound in diagnosing malignant breast lesions taking histopathology as gold standard. Pak J Health Sci. 2024;5(2):36–41. https://doi.org/10.54393/pjhs.v5i06.1657
17. Shaikh R, Khan AA. Diagnostic accuracy of mammography in symptomatic patients at Civil Hospital, Karachi. J Dow Univ Health Sci. 2017;11(2):41–5. https://doi.org/10.36570/jduhs.2017.2.510
18. Manzoor A, Rafique I, Naseer S. Diagnostic accuracy of sonomammography in diagnosis of BIRADS 4 suspicious breast lesions keeping histopathology as gold standard. Pak J Med Sci. 2021;37(5):131–5. https://doi.org/10.53350/pjmhs2115102772
19. Ahmed ZT, Ameer S, Tanveer M, Tanveer F. Diagnostic accuracy of ultrasound in differentiating benign and malignant breast masses taking histopathology as gold standard. Med Forum Mon. 2020;31(4):45–9.
20. Khan Z, Saleem M, Bhutta M, Ullah N, Fatima U, Yousuf M. Diagnostic accuracy of ultrasonography in the diagnosis of breast carcinoma in mammographically dense breasts: histopathology as the gold standard. J Soc Obstet Gynaecol Pak. 2023;13(4):398–402.
21. Akhund J, Memon S, Qamber J, Rashid I, Elhaj A, Alshammari A. Ultrasound vs mammography in evaluating suspicious breast lesions. Biol Clin Sci Res J. 2023;2023(1):288. https://doi.org/10.54112/bcsrj.v2023i1.288
22. Gharekhanloo F, Haseli MM, Torabian S. Value of ultrasound in the detection of benign and malignant breast diseases: a diagnostic accuracy study. Oman Med J. 2018;33(5):380. https://doi.org/10.5001/omj.2018.71
23. Majeed AI, Naz N, Arif M, Majeed A. Diagnostic accuracy of mammography in detecting breast cancer keeping histopathology as gold standard. Ann Pak Inst Med Sci. 2016;12(2):228–32.