Research Article

Cuestiones de Fisioterapia

Medicine

DIAGNOSTIC ACCURACY OF ULTRASONOGRAPHY COMPARED WITH MAMMOGRAPHY IN THE EVALUATION OF PALPABLE BREAST LUMPS: A CROSS-SECTIONAL STUDY FROM A TERTIARY CARE TEACHING HOSPITAL

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Abstract

Background: Palpable breast lumps are a common presenting complaint among women attending outpatient services in South India, and accurate, timely triage into benign and malignant categories is essential for appropriate management. Ultrasonography (USG) and mammography are the two principal imaging modalities available at most tertiary centres, but their comparative performance in a relatively young, dense-breasted South Indian population is incompletely characterized. Objective: To determine and compare the diagnostic accuracy of high-resolution USG and mammography, individually and in combination, against histopathology as the reference standard, in women presenting with palpable breast lumps. Methods: This hospital-based cross-sectional diagnostic accuracy study was conducted in the Department of Radiodiagnosis, tertiary care teaching hospital, India, during sixs months. Consecutive women with a palpable breast lump underwent high-resolution USG and mammography, each interpreted with the Breast Imaging-Reporting and Data System (BI-RADS), followed by histopathological confirmation. Sensitivity, specificity, positive and negative predictive values (PPV, NPV) and accuracy were computed for each index test; overall correct classification was compared using the McNemar test ($p<0.05$). Results: Among 240 women (mean age 44.8 +/- 13.7 years; 72.5% premenopausal), histopathology confirmed malignancy in 85 (35.4%). USG achieved a sensitivity of 95.3%, specificity 83.9%, PPV 76.4%, NPV 97.0% and accuracy 87.9%, whereas mammography achieved a sensitivity of 89.4%, specificity 89.0%, PPV 81.7%, NPV 93.9% and accuracy 89.2%. Combined testing (either modality positive) raised sensitivity to 98.8% and NPV to 99.2% but reduced specificity to 76.1%. The McNemar comparison of overall correct classification showed no statistically significant difference between USG and mammography (discordant pairs b=20, c=23; p=0.76). Conclusion: In this young, dense-breasted South Indian cohort, USG was more sensitive and mammography more specific, with comparable overall accuracy. The two modalities are complementary; combined testing maximises sensitivity and NPV. USG is a valuable first-line and adjunct test for the evaluation of palpable breast lumps in South India.

Keywords: Breast neoplasms; Ultrasonography, mammary; Mammography; Diagnostic accuracy; Sensitivity and specificity; South India

INTRODUCTION

Breast lumps are among the most frequent reasons for which women seek surgical and radiological consultation, and the central clinical task is to distinguish benign disease from malignancy accurately and expeditiously. Although the majority of palpable breast lumps prove benign, the possibility of underlying carcinoma mandates a systematic diagnostic approach so that malignant lesions are neither missed nor subjected to unnecessary delay. The evaluation of a palpable breast abnormality classically integrates clinical examination, imaging and needle sampling within the framework of triple assessment, and imaging occupies a pivotal position in this pathway [1,2].

Two imaging modalities dominate the assessment of breast lumps in most tertiary care settings: mammography and high-resolution ultrasonography (USG). Mammography, particularly in its full-field digital form, is the cornerstone of population screening and remains highly effective at detecting microcalcification and architectural distortion, but its sensitivity is well recognised to decline in radiographically dense breasts, which are more prevalent in younger women [8,9,10]. USG, by contrast, is inexpensive, widely available, free of ionising radiation and particularly well suited to characterising cystic versus solid lesions and to evaluating dense breast tissue [3,4]. These complementary strengths have prompted continued interest in defining the optimal role of each modality, and in high-risk or diagnostically challenging populations the addition of further modalities such as magnetic resonance imaging has been explored [5,6].

The demographic profile of women presenting with breast disease in South India differs in important respects from that reported in Western screening populations. Indian women, including those in the southern states, tend to present with breast carcinoma at a younger age and frequently have radiographically dense breasts, and a substantial proportion of breast cancers occur in women under 40 years of age [11,12,13]. These features have direct implications for imaging strategy, because the reduced mammographic sensitivity in dense breasts may leave a proportion of malignancies undetected if mammography is relied upon in isolation. Consequently, understanding the comparative and complementary performance of USG and mammography in this specific population is of considerable practical importance for radiologists and surgeons working in South Indian tertiary care teaching hospitals.

Despite the clinical relevance of this question, locally generated diagnostic accuracy data comparing the two modalities against a histopathological reference standard remain relatively limited. Much of the available evidence derives from screening cohorts or from populations with a different age structure and breast density distribution, limiting direct extrapolation to the symptomatic South Indian patient with a palpable lump. There is therefore a need for structured, reference-standard-anchored evaluations conducted within the South Indian tertiary care context, so that imaging pathways can be tailored to the population actually being served.

The present study was undertaken to address this gap. We conducted a hospital-based cross-sectional diagnostic accuracy study among consecutive women presenting with a palpable breast lump, in whom both high-resolution USG and mammography were performed and interpreted using the Breast Imaging-Reporting and Data System (BI-RADS), with histopathology serving as the reference standard. The primary objective was to determine and compare the sensitivity, specificity, positive and negative predictive values and overall accuracy of USG and mammography, and to assess the incremental value of combining the two tests. We hypothesised that, in this young and predominantly dense-breasted South Indian population, USG would demonstrate higher sensitivity and mammography higher specificity, with the two modalities functioning in a complementary manner.

MATERIALS AND METHODS

Study design and setting

This was a hospital-based cross-sectional diagnostic accuracy study conducted in the Department of Radiodiagnosis, tertiary care teaching hospital, India. The study was carried out over the period six months. The reporting of the study was made consistent with the Standards for Reporting of Diagnostic Accuracy Studies (STARD) framework, covering participant flow, index tests, reference standard and estimates of diagnostic accuracy.

Participants

Consecutive women presenting to the department with a clinically palpable breast lump during the study period were considered for inclusion. Eligible participants were adult women in whom both index imaging tests and subsequent histopathological sampling were performed. Women without a definitive histopathological reference diagnosis, and those in whom imaging could not be completed, were not included in the analytic sample. Each participant contributed a single index breast lump to the analysis.

Index tests

Two index tests were performed for every participant. High-resolution USG of the breast was carried out using a high-frequency linear-array transducer, with lesions characterised for shape, margins, orientation, internal echotexture and posterior acoustic features, and assigned a BI-RADS category. Mammography was performed with standard craniocaudal and mediolateral oblique projections, and each study was assigned a BI-RADS category and a mammographic breast density category (A, fatty; B, scattered fibroglandular; C, heterogeneously dense; D, extremely dense). For the purpose of dichotomising each index test, BI-RADS categories were classified as a positive (suspicious for malignancy) or negative (benign) test result according to prespecified thresholds, and a combined test result was defined as positive when either USG or mammography was positive. Imaging interpreters were aware that participants were symptomatic but assigned imaging categories before histopathological results were available.

Reference standard

Histopathological examination of tissue obtained from the index lesion served as the reference standard for all participants. Each lesion was classified as malignant or benign on histopathology, and the specific histopathological diagnosis was recorded. This reference standard was applied uniformly to participants irrespective of their index test results.

Statistical analysis

Continuous variables were summarised as mean and standard deviation (SD), and categorical variables as frequencies and percentages. For each index test and for the combined strategy, two-by-two contingency tables were constructed against the histopathological reference standard, and sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and overall accuracy were calculated; 95% confidence intervals were considered conceptually to frame the precision of these point estimates. The overall correct classification of USG and mammography was compared using the McNemar test for paired proportions, with a two-sided p-value of less than 0.05 regarded as statistically significant. Analyses were performed on the full dataset of 240 records.

RESULTS

Baseline characteristics

A total of 240 women with a palpable breast lump were included. The mean age was 44.8 +/- 13.7 years, and the cohort was predominantly premenopausal, with 174 women (72.5%) premenopausal and 66 (27.5%) postmenopausal. The mean lump size was 2.7 +/- 1.2 cm. Mammographic breast density was broadly distributed across categories, with 62 women (25.8%) classified as category A (fatty), 54 (22.5%) as category B (scattered fibroglandular), 64 (26.7%) as category C (heterogeneously dense) and 60 (25.0%) as category D (extremely dense); thus, just over half of the cohort (51.7%) had heterogeneously or extremely dense breasts. On the histopathological reference standard, 85 lesions (35.4%) were malignant and 155 (64.6%) were benign. Women with malignant lesions were, on average, older than those with benign disease (mean age 47.9 versus 43.0 years). The baseline characteristics of the study population are summarised in Table 1.

Table 1: Baseline characteristics of the study population (N=240)

Characteristic	Value
Age, years, mean +/- SD	44.8 +/- 13.7
Premenopausal, n (%)	174 (72.5)
Postmenopausal, n (%)	66 (27.5)
Lump size, cm, mean +/- SD	2.7 +/- 1.2
Mammographic density A - fatty, n (%)	62 (25.8)
Mammographic density B - scattered, n (%)	54 (22.5)
Mammographic density C - heterogeneously dense, n (%)	64 (26.7)
Mammographic density D - extremely dense, n (%)	60 (25.0)
Histopathology malignant, n (%)	85 (35.4)
Histopathology benign, n (%)	155 (64.6)
Mean age, malignant lesions, years	47.9
Mean age, benign lesions, years	43.0

The spectrum of histopathological diagnoses was diverse and encompassed both benign and malignant entities. The most frequent diagnoses were mastitis or abscess (30 cases), intraductal papilloma (29), breast cyst (29), ductal carcinoma in situ (27), fibrocystic change (27), fibroadenoma (22), malignant phyllodes tumour (20) and benign phyllodes tumour (18), with the remaining lesions distributed among other benign and malignant categories including mucinous carcinoma, invasive lobular carcinoma and invasive ductal carcinoma. The distribution of principal histopathological diagnoses is displayed in Figure 2.

Diagnostic performance of ultrasonography

Against the histopathological reference standard, USG correctly identified 81 of 85 malignant lesions and correctly classified 130 of 155 benign lesions, with 25 false-positive and 4 false-negative results. This corresponded to a sensitivity of 95.3%, specificity of 83.9%, PPV of 76.4%, NPV of 97.0% and overall accuracy of 87.9%. The very low false-negative count (4 lesions) underlies the high sensitivity and NPV of USG, indicating that a negative USG was rarely associated with an underlying malignancy in this cohort.

The two-by-two table and derived metrics for USG are presented in **Table 2**.

Table 2: Ultrasonography versus histopathology: 2x2 table and diagnostic metrics

USG result	Malignant (histopathology)	Benign (histopathology)	Total
Positive	81 (TP)	25 (FP)	106
Negative	4 (FN)	130 (TN)	134
Total	85	155	240
Metric	Value		
Sensitivity	95.3%		
Specificity	83.9%		
Positive predictive value	76.4%		
Negative predictive value	97.0%		
Accuracy	87.9%		

Diagnostic performance of mammography

Mammography correctly identified 76 of 85 malignant lesions and correctly classified 138 of 155 benign lesions, with 17 false-positive and 9 false-negative results. This yielded a sensitivity of 89.4%, specificity of 89.0%, PPV of 81.7%, NPV of 93.9% and overall accuracy of 89.2%. Compared with USG, mammography produced fewer false-positive results (17 versus 25), accounting for its higher specificity and PPV, but it generated more than twice as many false-negative results (9 versus 4), reflecting its lower sensitivity in this population. The corresponding two-by-two table and metrics are shown in Table 3.

Table 3: Mammography versus histopathology: 2x2 table and diagnostic metrics

Mammography result	Malignant (histopathology)	Benign (histopathology)	Total
Positive	76 (TP)	17 (FP)	93
Negative	9 (FN)	138 (TN)	147
Total	85	155	240
Metric	Value		
Sensitivity	89.4%		
Specificity	89.0%		
Positive predictive value	81.7%		
Negative predictive value	93.9%		
Accuracy	89.2%		

Combined testing and head-to-head comparison

When the two modalities were combined such that a lesion was regarded as positive if either USG or mammography was positive, sensitivity rose to 98.8% and NPV to 99.2%, with only a single malignant lesion (1 false negative) missed by both tests. This gain in sensitivity was achieved at the expense of

specificity, which fell to 76.1%, with a corresponding rise in false-positive results to 37 and a reduction in PPV to 69.4%; overall accuracy of the combined strategy was 84.2%. The complementary behaviour of the two modalities is evident in the grouped comparison of diagnostic metrics displayed in Figure 1.

The head-to-head comparison of overall correct classification between USG and mammography, using the McNemar test, revealed discordant pairs of b=20 and c=23 and a p-value of 0.76, indicating no statistically significant difference in overall diagnostic accuracy between the two modalities. Thus, while the two tests differed in the balance of sensitivity and specificity, neither was globally superior in terms of correct classification. Table 4 provides a side-by-side summary of all three strategies together with the McNemar comparison.

Table 4: Side-by-side comparison of USG, mammography and combined testing, with McNemar comparison

Metric	USG	Mammography	Combined (USG or mammography)
True positives	81	76	84
False positives	25	17	37
False negatives	4	9	1
True negatives	130	138	118
Sensitivity	95.3%	89.4%	98.8%
Specificity	83.9%	89.0%	76.1%
Positive predictive value	76.4%	81.7%	69.4%
Negative predictive value	97.0%	93.9%	99.2%
Accuracy	87.9%	89.2%	84.2%
McNemar (USG vs mammography)	b=20, c=23	p=0.76	Not significant

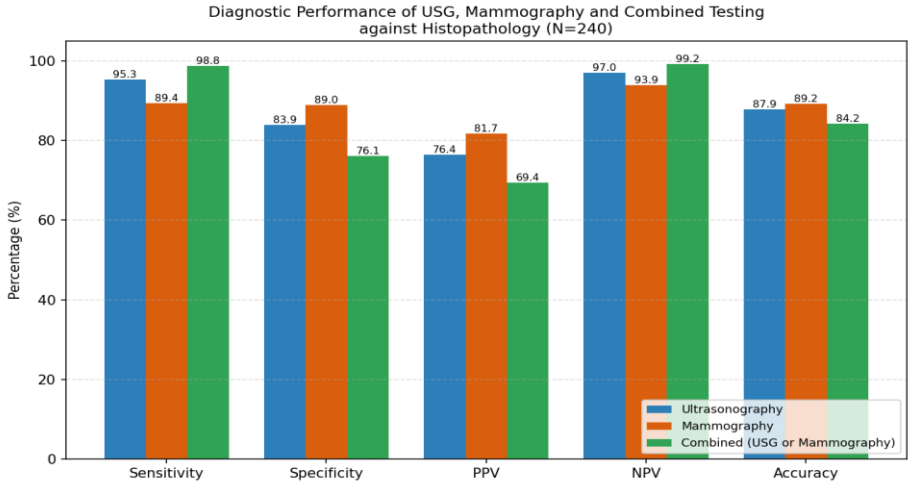

Figure 1: Grouped bar chart comparing sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy (%) of ultrasonography, mammography and combined testing against histopathology (N=240). USG shows the highest sensitivity and NPV, mammography the highest

specificity and PPV, and combined testing the highest overall sensitivity and NPV at the cost of specificity.

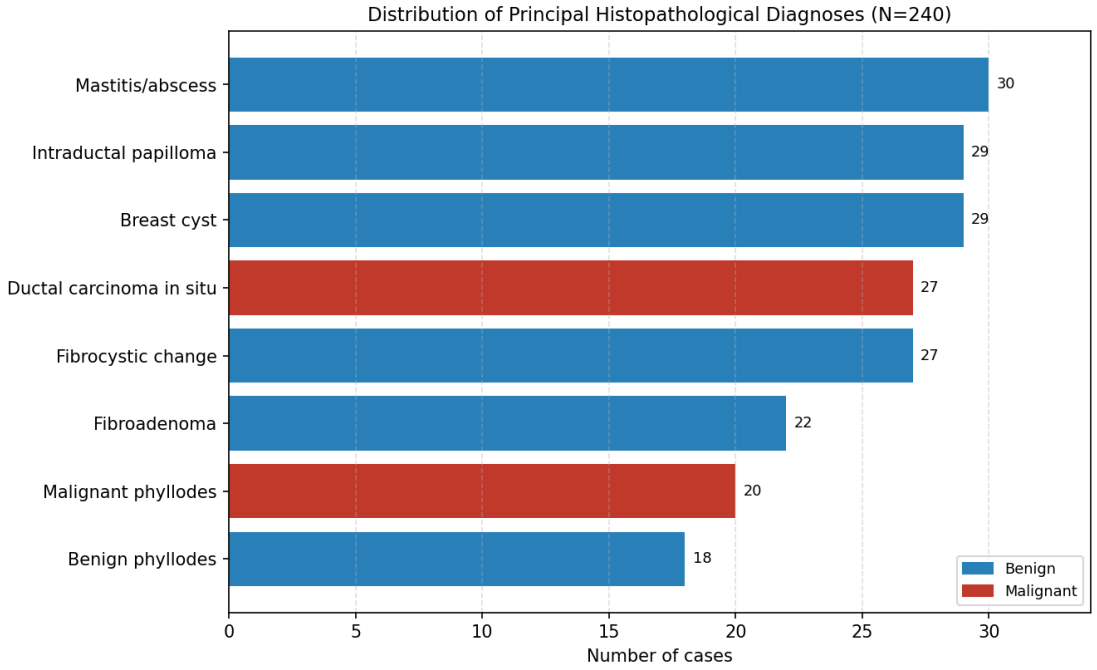

Figure 2: Distribution of principal histopathological diagnoses in the study population (N=240). Malignant categories are shown in red and benign categories in blue. The most frequent diagnoses were mastitis/abscess, intraductal papilloma and breast cyst among benign lesions, and ductal carcinoma in situ and malignant phyllodes tumour among malignant lesions.

Discussion

In this cross-sectional diagnostic accuracy study of 240 women presenting with a palpable breast lump at a tertiary care teaching hospital in South India, USG and mammography demonstrated distinct but complementary diagnostic profiles. USG was the more sensitive modality (sensitivity 95.3%, NPV 97.0%), whereas mammography was the more specific (specificity 89.0%, PPV 81.7%). Overall accuracy was closely comparable (87.9% for USG and 89.2% for mammography), and the McNemar comparison confirmed that the difference in overall correct classification was not statistically significant (p=0.76). Combining the two modalities produced a very high sensitivity of 98.8% and an NPV of 99.2%, missing only a single malignancy, at the cost of reduced specificity. These findings support the view that USG and mammography are best regarded as partners rather than competitors in the evaluation of the symptomatic breast.

The observed superiority of USG in sensitivity is biologically and technically coherent in the context of the population studied. The cohort was young, with a mean age of 44.8 years, and predominantly premenopausal, and just over half of the women had heterogeneously or extremely dense breasts on mammography. It is well established that mammographic sensitivity declines in dense breast tissue, where fibroglandular tissue can obscure or mimic malignant lesions [8,9,10]. USG is comparatively unaffected by breast density and excels at distinguishing solid from cystic lesions and at characterising the margins and vascularity of solid masses [3,4]. In a population such as ours, in which dense breasts and younger age predominate, these properties translate directly into fewer false-negative results, as reflected in the four false negatives with USG versus nine with mammography. This pattern is consistent with the demographic

realities of breast disease in India, where women frequently present at a younger age and a considerable proportion of cancers arise in women under 40 years [11,12,13].

The complementary specificity advantage of mammography is equally important. Mammography detected fewer false positives (17 versus 25) and therefore achieved higher specificity and PPV, reflecting its recognised strength in identifying features such as microcalcification and architectural distortion that may not be as readily appreciated on USG. The combined strategy, in which either positive test triggered a suspicious classification, capitalised on the sensitivity of USG and captured all but one malignancy, driving the NPV to 99.2%. However, the accompanying fall in specificity to 76.1% and the rise in false positives to 37 illustrate the inevitable trade-off: a strategy optimised to avoid missing cancer will generate more benign lesions requiring further evaluation. In clinical terms, the combined approach is attractive when the priority is to minimise missed malignancy, as in the initial triage of a palpable lump, provided that the resulting positive findings are appropriately resolved through tissue sampling within the triple assessment framework [1,2].

These results align with the broader literature on breast imaging. Reviews of breast USG have emphasised its value as an adjunct to mammography, particularly in dense breasts and in the characterisation of cystic lesions [3,4]. Evaluations of digital mammography have documented its diagnostic performance and the dependence of that performance on breast density [8,9,10]. In higher-risk populations, additional modalities such as magnetic resonance imaging have been shown to improve sensitivity further, underscoring the general principle that multimodality assessment enhances cancer detection [5,6]. Studies employing alternative approaches, including functional imaging with Tc-99m-MIBI in correlation with mammography and sonography, similarly reflect the ongoing effort to optimise the diagnostic pathway for breast lesions [7]. Within the Indian context, the emphasis on triple assessment and the recognition of a younger age at presentation reinforce the applicability of a USG-inclusive strategy [2,11,12,13].

The implications for practice in South India are practical and immediate. USG is inexpensive, portable, free of ionising radiation and highly sensitive in exactly the type of breast tissue that predominates in this population. It is therefore well suited to serve as a first-line or adjunct investigation for palpable breast lumps in South Indian tertiary care teaching hospitals, both to characterise lesions and to guide tissue sampling. Mammography retains a crucial role, particularly for its specificity and its ability to detect calcification, and the two modalities used together offer the most robust safeguard against missed malignancy. A pragmatic, resource-conscious pathway that deploys USG liberally in younger, dense-breasted women, complemented by mammography, is likely to serve the South Indian population well.

Several limitations should be acknowledged. Most importantly, the analysis was based on a teaching dataset of 240 records; The single-centre, cross-sectional design limits generalisability, and consecutive sampling at a tertiary referral centre may introduce spectrum effects that differ from primary care populations. Imaging interpretation, although performed before histopathology was available, may be subject to inter-observer variability that a single-reader analysis does not capture. Confidence intervals were considered conceptually rather than reported numerically for every estimate, and the study did not incorporate cost-effectiveness or downstream outcome measures. Finally, the reference standard was histopathology of the index lesion, which is appropriate but does not account for occult disease elsewhere. Future prospective, multicentre studies in South Indian populations, incorporating inter-observer agreement and formal interval estimation, would strengthen and extend these observations.

Conclusion

In this cross-sectional diagnostic accuracy study of women with palpable breast lumps at a tertiary care teaching hospital in South India, USG was more sensitive and mammography more specific, with statistically comparable overall accuracy. The two modalities are complementary, and combined testing maximised sensitivity and negative predictive value, missing only a single malignancy. In a relatively young, dense-breasted South Indian population, high-resolution USG is a valuable first-line and adjunct investigation for the evaluation of palpable breast lumps, and its use alongside mammography within a triple-assessment pathway offers the most reliable protection against missed breast cancer.

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