INPLASY

Diagnostic value of Contrast-Enhanced Ultrasound plus strain elastography in identifying benign and malignant breast mass: A systematic Review and Meta-Analysis

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ADMINISTRATIVE INFORMATION

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Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 22 December 2025 and was last updated on 22 December 2025.

INTRODUCTION

Review question / Objective The incidence rate of breast cancer is increasing year by year, so the early diagnosis of breast cancer is very important. Contrast enhanced ultrasound and elastography are increasingly used in the diagnosis of breast cancer. The purpose of this systematic evaluation is to evaluate their diagnostic value on identifying the characteristic of breast lesions.this review will evaluate the outcomes according on sensitivity , specificity and accuracy.

Rationale Breast cancer remains a leading cause of morbidity and mortality among women worldwide, necessitating the development of effective diagnostic tools. Traditional ultrasound has been widely used for breast cancer detection; however, its sensitivity and specificity can vary significantly. Recent advancements in imaging techniques, such as contrast-enhanced ultrasound (CEUS) combined with elastography, have shown promise in improving diagnostic accuracy. Preliminary studies suggest that these combined modalities may enhance the detection of breast lesions, potentially leading to earlier diagnosis and better patient outcomes. Despite these advancements, there is a lack of comprehensive reviews that systematically evaluate the comparative effectiveness of CEUS combined with elastography versus traditional ultrasound in terms of sensitivity, specificity, and overall accuracy. This review aims to fill this gap in the literature, providing a clearer understanding of the diagnostic capabilities of these imaging techniques in breast cancer patients.

Condition being studied In recent decades, the global incidence of breast cancer has continued to rise, with a noticeable trend toward younger age at diagnosis. Early detection and accurate diagnosis are crucial, as patients with early-stage breast cancer generally have a favorable prognosis,

whereas delayed diagnosis is associated with significantly poorer survival outcomes. Therefore, improving the accuracy of early diagnostic methods for breast cancer is of great clinical importance.

Contrast-enhanced ultrasound (CEUS) is an advanced imaging technique that involves the intravenous administration of ultrasound contrast agents to dynamically visualize microvascular perfusion within tissues.similarly,Ultrasound elastography is a noninvasive imaging technique that evaluates tissue stiffness by measuring tissue deformation in response to an applied force. Because malignant breast tumors are generally stiffer than benign lesions due to increased cellular density, desmoplastic reaction, and altered tissue architecture, elastography provides additional biomechanical information beyond conventional B-mode ultrasound

The combination of contrast-enhanced ultrasound (CEUS) and ultrasound elastography provides complementary information for the diagnosis of breast cancer. CEUS evaluates tumor microvascular perfusion and enhancement patterns, while elastography assesses tissue stiffness. Malignant breast lesions typically demonstrate abnormal vascularity and increased stiffness compared with benign lesions. By integrating vascular and biomechanical characteristics, the combined approach improves the accuracy of differentiating malignant from benign breast lesions. Several studies have shown that CEUS combined with elastography can enhance diagnostic sensitivity and specificity and reduce diagnostic uncertainty compared with either modality alone.

METHODS

Participant or population Adults with breast masses, diagnosed as benign or malignant through any recognized diagnostic criteria. Exclusion: Individuals with breast masses that are not characterized as benign or malignant, such as cysts or other non-mass lesions.

Intervention The intervention will be defined as the use of Contrast-Enhanced Ultrasound (CEUS) combined with strain elastography for the identification of benign and malignant breast masses.

Comparator This review will compare the intervention with standard imaging techniques such as conventional ultrasound. Additional comparators may include traditional ultrasound plus Contrast-Enhanced Ultrasound,or traditional ultrasound plus elastograph.

Study designs to be included Diagnostic research.

Eligibility criteria Inclusion criteria as follows:benign and malignant breast lesions not clearly definable before diagnosis; diagnosis of the same group of lesion by CEUS, UE, and their combination, respectively; a gold standard of pathological and histological diagnosis, such as puncture biopsy or surgical pathological examination

total number of lesions≥20. Meanwhile, the exclusion criteria were as follows: total number of lesions <20; a gold standard other than pathological histology; and case reports, reviews.

Information sources Pubmed, embase, cochrane ,web of science.

Main outcome(s) The Spearman correlation coefficient and P value were used to test the threshold effect. The I^2 value was >50%, indicating that there was heterogeneity between the studies, which might be related to the control population and the test method.

Therefore, the random effects model was used for statistical analysis. The overall diagnostic accuracy (ACC) of CEUS, SWE, and their combination for benign and malignant breast lesions was evaluated by calculating the pooled SEN, SPE, PLR, NLR, and DOR and by drawing the summary receiver operating characteristic (SROC) curve, drafting forest plots, and calculating the AUC.

Data management Endnote.

Quality assessment / Risk of bias analysis Cochrane TOOL.

Strategy of data synthesis Primary outcomes (pooled SEN/SPE) analyzed via bivariate random effects model; summary AUC via HSROC model. Secondary: DOR , PLR/NLR (Fagan nomogram application). Heterogeneity: I^2 statistics, subgroup analyses (segmentation/ classifier/ROI/QUADAS-2 risk), meta-regression (sample size/year). Sensitivity: Leave-one-out, Bayesian models, clinical scenario restrictions. Publication bias: Deeks' funnel plot asymmetry test ($p<0.10$). Software: R (mada/metafor), Stata (midas).

Subgroup analysis Prespecified subgroups: (1)Segmentation methods (auto/semi-auto/ manual),(2) Classifier types (statistical/ML/DL), (3) Feature integration (imaging-only/imaging+clinical), (4)Imaging modalities (MRI/US/mammography/CT/ PET-CT), (5) ROI targets (primary tumor/LN/ combined). Analyzed via bivariate meta-regression

with interaction tests difference in SEN/SPE,between subgroups. Sensitivity: Merge small subgroups.

Sensitivity analysis Compare bivariate vs. HSROC models; Bayesian sensitivity analysis; Exclusion-based: Remove high-bias studies (QUADAS-2 ≥2 high-risk domains), small samples (n2mm), single-modality subgroups. Robustness threshold: 80% 95% CI overlap. Technical covariate impact: ΔAUC >0.05 for autosegmentation studies.

Country(ies) involved China.

Keywords Contrast-Enhanced Ultrasound, strain elastography, breast mass, benign, malignant.

Contributions of each author
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