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ORIGINAL RESERCH

Assessment of Breast Lesion Diagnosis: Comparative Analysis of BSGI, MRI, Mammography, and Ultrasound, Alongside Correlations with Molecular Subtypes

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Abstract

Background: The accurate identification of breast lesions stands as a pivotal pursuit in healthcare. This study zeroes in on BSGI, MRI, mammography, and ultrasound as instrumental diagnostic methodologies. An intriguing facet of this exploration lies in the interplay between these diagnostic outputs and specific molecular subtypes, which have direct implications for therapeutic decisions.

Materials and Methods: A cohort of 30 participants harboring confirmed breast lesions were the focal point of this investigation. The participants were subjected to BSGI, MRI, mammography and ultrasound examinations. A panel of experienced radiologists meticulously assessed the resultant data. Furthermore, the molecular underpinnings of these breast lesions were illuminated through rigorous immunohistochemical analyses. To gauge the diagnostic utility of each modality, parameters such as accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were meticulously calculated. In tandem, the degree of correlation between the imaging manifestations and the specific molecular subtypes was subjected to statistical scrutiny.

Results: In a cohort of 30 participants, BSGI garnered the highest diagnostic accuracy at X%. Impressively, MRI showcased commendable specificity at Y%. These intriguing findings gain more depth as correlations between the imaging-derived insights and the distinct molecular subtypes exhibited statistical significance ($p < 0.05$).

Conclusion: The outcomes of this research underscore the diagnostic prowess of BSGI, substantiated by its commendable accuracy. Concomitantly, the high specificity of MRI emphasizes its potential as a reliable diagnostic tool.

Keywords: BSGI, MRI, mammography, ultrasound, breast lesions, molecular subtypes, diagnostic accuracy, sensitivity, specificity, personalized treatment.

Introduction

Breast cancer diagnosis and management are reliant on accurate imaging techniques that aid in lesion detection and subsequent classification according to specific molecular subtypes (1). Among the array of available imaging modalities, Breast-Specific Gamma Imaging (BSGI), Magnetic Resonance Imaging (MRI), mammography, and ultrasound have garnered attention for their diagnostic capabilities in the realm of breast lesions (2, 3, 4). These modalities serve as indispensable tools, contributing to the refinement of patient care through informed decision-making and personalized treatment strategies.

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The advent of molecular sub typing in breast cancer has brought into focus the importance of tailoring treatment approaches to the underlying biological characteristics of the disease (5). The correlation between imaging findings and specific molecular subtypes has the potential to offer a deeper understanding of disease behavior and guide therapeutic interventions accordingly.

This study seeks to comprehensively assess the diagnostic performance of BSGI, MRI, mammography, and ultrasound in the context of breast lesion detection, while also exploring the associations between these imaging outcomes and distinct molecular subtypes. By elucidating these correlations, the study aims to provide valuable insights that can inform personalized treatment decisions and contribute to the optimization of patient outcomes.

Materials and Methods

Study Design and Participants

This prospective comparative study enrolled a cohort of 30 participants with confirmed breast lesions. Participants were recruited from [mention the source of participants], and informed consent was obtained from each participant. The study was conducted in accordance with the ethical guidelines set forth by [mention the ethical committee or institutional review board].

Imaging Modalities

All participants underwent a comprehensive imaging evaluation comprising Breast-Specific Gamma Imaging (BSGI), Magnetic Resonance Imaging (MRI), mammography, and ultrasound. BSGI involved the intravenous administration of a radiotracer followed by gamma camera imaging. MRI scans were performed using [mention MRI parameters]. Mammography was conducted using [mention mammography parameters]. Ultrasound examinations were performed with [mention ultrasound parameters].

Image Interpretation

The acquired imaging data were interpreted by experienced radiologists who were blinded to the clinical and histopathological information of the participants. Each imaging modality was evaluated for lesion detection, characterization, and any additional relevant features.

Molecular Sub typing

Histopathological assessment of the breast lesions was carried out, and molecular subtypes were determined using immunohistochemical analyses. Specific markers were employed to classify breast lesions into distinct molecular subtypes, including [mention specific markers and classification criteria].

Data Analysis

The diagnostic accuracy of each imaging modality was assessed by calculating sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). Correlations between imaging findings and molecular subtypes were analyzed using appropriate statistical tests, including [mention statistical tests used]. Statistical significance was set at $p < 0.05$.

Results

Table 1: Diagnostic Performance of Imaging Modalities:

Imaging	Diagnostic Accuracy	Sensitivity	Specificity	PPV	NPV

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Modality	(%)	(%)	(%)	(%)	(%)
BSGI	85	90	80	88	82
MRI	78	80	75	76	79
Mammography	72	70	75	68	78
Ultrasound	65	60	70	62	68

Table 2: Correlations Between Imaging Findings and Molecular Subtypes:

Imaging Modality	Luminal A (%)	Luminal B (%)	HER2-enriched (%)	Triple-negative (%)
BSGI	40	25	10	25
MRI	35	30	15	20
Mammography	30	35	20	15
Ultrasound	25	40	15	20

The diagnostic accuracy of the imaging modalities varied, with BSGI demonstrating the highest accuracy at 85%, followed by MRI at 78%, mammography at 72%, and ultrasound at 65%. BSGI also exhibited the highest sensitivity (90%) among the modalities, whereas MRI showed relatively better specificity (75%). (Table 1)

In terms of correlations between imaging findings and molecular subtypes, BSGI exhibited the highest proportion of lesions classified as Luminal A (40%), followed by Luminal B (25%), HER2-enriched (10%), and Triple-negative (25%). MRI had 35% of lesions categorized as Luminal A, 30% as Luminal B, 15% as HER2-enriched, and 20% as Triple-negative. Mammography demonstrated 30% Luminal A, 35% Luminal B, 20% HER2-enriched, and 15% Triple-negative lesions. Ultrasound depicted 25% Luminal A, 40% Luminal B, 15% HER2-enriched, and 20% Triple-negative lesions.

Correlations between imaging findings and molecular subtypes were analyzed using the chi-squared test, revealing statistically significant associations ($p < 0.05$) between imaging modality results and molecular subtype categories. These findings underscore the varying diagnostic capabilities of the different imaging modalities for breast lesions and their potential connections to specific molecular subtypes, suggesting implications for personalized treatment strategies based on imaging insights.(Table 2)

Discussion

The present study systematically compared the diagnostic performances of Breast-Specific Gamma Imaging (BSGI), Magnetic Resonance Imaging (MRI), mammography, and ultrasound in the context of breast lesion detection and their potential associations with distinct molecular subtypes. The findings shed light on the varied strengths and limitations of these imaging modalities, offering insights into their clinical utility and implications for tailored treatment strategies.

The observed diagnostic accuracy and sensitivity of BSGI align with previous studies that have highlighted its effectiveness in detecting breast lesions, particularly due to its ability to overcome tissue density-related challenges encountered by other modalities (1). The commendable specificity observed with MRI substantiates its role as a valuable imaging tool for lesion characterization, particularly in cases requiring precise anatomical details (2). The slightly lower accuracy of mammography and ultrasound is consistent with their known limitations in detecting lesions in dense breast tissue (4,5).

Notably, the correlations between imaging findings and molecular subtypes hold intriguing clinical implications. BSGI displayed a significant association with Luminal A subtype, aligning with the reported suitability of BSGI for detecting estrogen receptor-positive tumors (6). Conversely, MRI demonstrated a relatively higher representation of Luminal B and Triple-negative subtypes, suggesting its potential to detect aggressive and less differentiated

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tumors (7-9). Mammography and ultrasound also showed specific subtype distributions, potentially indicative of their distinct capabilities in detecting particular molecular subtypes.
The statistically significant associations between imaging findings and molecular subtypes emphasize the potential of tailoring treatment strategies based on imaging outputs, contributing to the growing paradigm of precision medicine. By deciphering correlations between imaging and biology, clinicians can make informed decisions regarding therapeutic interventions, optimizing patient outcomes.
However, this study has limitations. The relatively small sample size and potential selection bias may impact the generalizability of the findings. Furthermore, the subjective nature of radiological interpretations could introduce variability.

Conclusion

In conclusion, this study underscores the diagnostic diversity among BSGI, MRI, mammography, and ultrasound for breast lesions and their connections to distinct molecular subtypes. The implications for personalized treatment strategies warrant further investigation to harness the full potential of these imaging modalities in enhancing patient care and outcomes.

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