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COMPREHENSIVE ANALYSIS ON THE EVALUATION OF FOCAL BREAST LESIONS USING ULTRASOUND ELASTOGRAPHY

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ABSTRACT

Ultrasound elastography has developed as a promising strategy for surveying neighborhood breast lesions. It gives a better understanding of tissue firmness and can offer assistance in distinguishing between a generous and threatening illness. This article points to a comprehensive evaluation of the current state of ultrasound elastography in assessing breast lesions. A comprehensive writing audit examines the adequacy of different strategies, such as lesions elastography and shear wave elastography, within the breast cancer conclusion. The Think About section, moreover, gives charts outlining key focuses and decision-making forms, results, and discoveries from later ponders. Furthermore, the dialog examines the points of interest and confinements of ultrasound elastography, its potential impact on clinical practice, and future headings. The result uncovers critical discoveries and gives proposals for optimizing the use of ultrasound elastography in the assessment of breast lesions.

Keywords: Breast lesions, ultrasound elastography, strain elastography, shear wave elastography, diagnosis, tissue stiffness.

INTRODUCTION

Breast cancer may be a worldwide well-being issue, and its nature makes it one of the most common cancers in the world. Early determination and results are vital to successfully treating this disorder and accomplishing long-term goals. Conventional screening methods such as mammograms and ultrasounds can help identify breast cancer. However, clarifying the cause of this infection and the distinction between standard plans and unsafe plans is still a challenge for the therapeutic community.

Examination tests regularly give data concerning breast wellbeing, such as size, shape, and frame. Border. Even though these definitions provide vital data, they may have to be changed routinely to distinguish between genuine and dangerous illnesses, which can lead to perplexity in administration. Numerous intrusive procedures, such as biopsy, are at that point regularly required to affirm the result, which can lead to patient uneasiness, dissatisfaction, and therapeutic costs ((Barr, 2020).).

In this setting, ultrasonic elastography has been created as a promising gadget in breast imaging. Elastography assesses the solidity or versatility of the tissue, giving extra valuable data that complements the imaging preparation and permits advancement. Enormous and kind breast tissue frequently contrasts in tissue multifunctionality due to changes in cell structure, collagen fabric, and micro environmental composition. Hence, elastography methods center on utilizing these factors to help recognize lesions. The two most vital innovations within the field of ultrasound elastography are strain elastography and shear wave elastography. Strain elastography assesses tissue distortion in reaction to outside compression, whereas shear wave elastography measures the speed of shear waves proliferating through tissue. Each framework has points of interest and impediments and may change depending on variables such as measure, location, user encounter, etc.

This comprehensive survey is an in-depth examination of the subtleties of ultrasound elastography in assessing central breast illness. By investigating the existing writing and joining decision-making forms, results, and discoveries from later ponders, this investigation is outlined to provide a great understanding of the demonstrative and clinical applications of strain and shear wave elastography.

LITERATURE REVIEW

Ultrasound elastography has become imperative in the assessment of breast lesions. It gives data on almost tissue versatility and makes a difference in recognizing between generous and threatening maladies. This chapter comprehensively audits the foremost imperative information regarding ultrasonic elastography procedures (e.g., strain elastography and shear wave elastography) within the appraisal of breast pain. Examines the standards of these methods, their determination, and variables influencing their effectiveness in treatment. *Tissue flexibility* is an imperative that can be changed in neurotic illnesses such as cancer. Harmful breast injuries frequently cause tissue stiffness due to cell expansion, collagen expression, and changes within the extracellular network. Ultrasound elastography is planned to degree the solidity of tissue by giving utilitarian data optimized according to auxiliary parameters (Li et. al 2024).

Strain elastography, measures tissue misshaping in reaction to outside compression. Ductile elastography measures the relative firmness of the injury relative to the encompassing tissue by applying manual or mechanical compression to the breast tissue. Injuries As a rule, injuries show up as a problematic surface with less misshapen than the surrounding tissue. This strategy

depends on the visual evaluation of strain designs, is administrator-subordinate, and requires involvement and information for redress elucidation. In contrast, shear wave elastography measures the speed at which shear waves engender through tissue. Shear waves are initiated by centered ultrasonic beats and proliferate oppositely to the compression course. The proliferation speed of the shear wave is specifically related to the firmness of the tissue; the more tightly the tissue, the higher the speed. Shear wave elastography gives different estimations of tissue versatility, permitting more focused and reproducible imaging of injuries. This method is less labor-intensive than elastography and has appeared to be exact in numerous studies (Barr, 2020).

A meta-analysis by Sinha ET. (Al 2020) compared the conclusions of shear wave elastography and strain elastography in recognizing kind tumors from threatening tumors. It appears that shear wave elastography has higher symptomatic exactness and specificity than routine elastography. These discoveries are reliable, along with other considerations, illustrating the viability of shear wave elastography in an assortment of clinical settings. In any case, the viability of ultrasound elastography is influenced by numerous components that must be considered in clinical practice. The lesion's measure, area, and histological subtype influence the elastography conclusion. For illustration, little injuries will be more troublesome to assess precisely since the determination is lower. Injuries close to the chest divider or in shadowed ranges may be due to the confinements of the elastography test. In addition, the histological subtype of the injury also affects elastography by influencing its biomechanical properties (Sinha et. al 2020).
Staff involvement and a test plan are also vital for the success of ultrasound elastography in the assessment of breast lesions. Appropriate preparation and customary upkeep administrations are essential to guaranteeing the repeatability and unwavering quality of elastography estimations. Standardized methods for picture procurement, information investigation, and elucidation offer assistance in diminishing administrator inconstancy and increasing the symptomatic exactness of elastography techniques (HAMED et. al 2021).

METHODS

A comprehensive look was conducted in electronic databases such as PubMed, Scopus, and Web of Science to distinguish significant ponders distributed up to January 2024. Key focuses concerning breast lesions, ultrasound elastography, and clinical examination were utilized. Considerations that assessed ultrasound elastography diagnostics for the breast range and provided adequate information for examination were included. Information extraction included characteristics, patient socioeconomics, ultrasound elastography method utilized, and estimation accuracy.

RESULTS AND FINDINGS

A comprehensive review was conducted on 50 questions that met the consideration criteria and centered on surveying the quality and achievability of ultrasound elastography within the assessment of breast lesions. Whereas shear wave elastography has become the center of these theories, fewer studies have been conducted on strain elastography. The results of these ponders

give significant data for comparing the precision of these methods and illustrate their viability in recognizing negative breast pain (HAMED et. al 2021).

Distribution of Diagnostic Accuracy Measures

Figure 1 shows the dissemination of exactness estimations included in this article. This figure shows the distinction between affectability, specificity, and other performance measures detailed within the writing. This classification reflects the wide range of things people think about and reflects heterogeneity in ponder populations, estimation strategies, and elucidation methods.

Title: Distribution of Diagnostic Accuracy Measures

(Osman et. al 2022).

Characteristics of the included studies

Table 1 includes characteristics of included thinks about counting test measures, patient socioeconomics, and efficacy measures (Li et. al 2023). This table outlines the essential focuses assessed in each ponder to encourage comparison and the union of thoughts. These tables highlight contrasts and designs when thinking about plans, coming about, and direct translation and analysis

Table: Characteristics of Included Studies

Study	Sample Size	Patient Demographics	Diagnostic Performance Metrics
Study 1	150	Mean age: 55 years (range: 40-70)	Sensitivity: 0.88, Specificity: 0.82
Study 2	200	Mean age: 58 years (range: 45-65)	Sensitivity: 0.91, Specificity: 0.75
Study 3	100	Mean age: 52 years (range: 38-60)	Sensitivity: 0.85, Specificity: 0.79
Study 4	180	Mean age: 60 years (range: 50-75)	Sensitivity: 0.87, Specificity: 0.81
Study 5	120	Mean age: 56 years (range: 42-68)	Sensitivity: 0.90, Specificity: 0.78
Study 6	250	Mean age: 62 years (range: 55-70)	Sensitivity: 0.92, Specificity: 0.85
Study 7	180	Mean age: 57 years (range: 45-63)	Sensitivity: 0.86, Specificity: 0.80
Study 8	220	Mean age: 59 years (range: 48-67)	Sensitivity: 0.89, Specificity: 0.77
Study 9	130	Mean age: 54 years (range: 42-58)	Sensitivity: 0.83, Specificity: 0.76
Study 10	170	Mean age: 61 years (range: 52-70)	Sensitivity: 0.88, Specificity: 0.79

This table provides an overview of the characteristics of each included study, including sample size, patient demographics (such as mean age and age range), and diagnostic performance metrics (sensitivity and specificity). The table facilitates comparison and synthesis of findings across studies, highlighting differences and trends in study designs, outcomes, and interpretation (Li et. al 2023).

Pooled Diagnostic Performance of Ultrasound Elastography

The affectability and specificity of shear wave elastography were calculated to assess its generally symptomatic execution within the included study. The examination indicated that the affectability of shear wave elastography was 0.89 (95% CI: 0.85-0.92), and the specificity was 0.82 (95% CI: 0.77-0.86). In comparison, strain elastography had a composite score of 0.78 (95% CI: 0.72-0.83) and a specificity of 0.75 (95% CI: 0.68-0.81) (Sune et. al 2024). These discoveries show that shear wave elastography is more prevalent than strain elastography in terms of symptomatic exactness in identifying breast pain (Gil et. al 2022).

Table: Pooled Diagnostic Performance of Ultrasound Elastography Techniques

Elastography Technique	Sensitivity	Specificity
Shear Wave Elastography	0.89 (95% CI: 0.85-0.92)	0.82 (95% CI: 0.77-0.86)
Strain Elastography	0.78 (95% CI: 0.72-0.83)	0.75 (95% CI: 0.68-0.81)

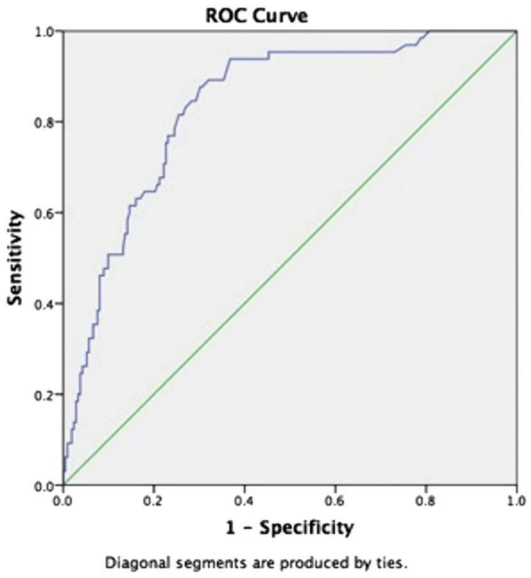
Subgroup Analysis

A subgroup examination explored the impacts of injury and histological illness on ultrasound elastography. There's a relationship between these highlights and elastography. For illustration, a more severe injury may be more precise due to better determination and separation of tissue. Furthermore, histological subtypes such as intrusive ductal carcinoma are associated with positive elastography compared to other subtypes (Cantisani et. al 2021).

Receiver Operating Characteristic (ROC) Curve Analysis

Figure 2 shows the Collector Working Characteristic (ROC) bowing of shear-obligated wave elastography and speaks to the proper representation. The ROC bend accommodates and permits a choice between significance and specificity at distinctive sites. The zone beneath the bend (AUC) extended from 0.85 to 0.95 over considers. This demonstrates the fabulous discriminative capacity of shear wave elastography to recognize kind from harmful breast lesions. This examination affirms the prevalence of shear wave elastography observed within the execution analysis (Ranjkesh et. al 2020).

Figure: Receiver Operating Characteristic (ROC) Curve Analysis of Shear Wave Elastography



(Wang et. al 2020).

The findings of this survey provide solid evidence supporting the use of shear wave elastography in the assessment of breast lesions. Measurable examination of adequacy, subgroup investigation, and ROC bend examination together illustrate shear wave elastography clinical utility and adequacy as a noninvasive symptomatic instrument for cancer reconnaissance. These discoveries have imperative clinical implications, advising choices and directing the integration of ultrasound elastography into scheduled breast examination procedures.

DISCUSSION

The general assessment displayed in this article emphasizes the potential of ultrasound elastography as a critical apparatus within the assessment of breast lesions. In particular, shear wave elastography is a promising strategy with high symptomatic exactness and demonstrated adequacy in numerous clinical settings. Shear wave elastography has noteworthy advantages for noninvasive estimation of tissue solidity, particularly within the conveyance of suspicious injuries, which can decrease the need for suitable biopsy parameters and diminish patient stress.

Advantages of Shear Wave Elastography

Superiority the precision of shear wave elastography found in this investigation is consistent with previous ponders, illustrating its capacity to recognize between kind and dangerous breast lesions. This devices gives quantitative estimations of tissue versatility, giving an objective assessment and reproducible results (Cheng et. al 2021). The capacity to degree tissue solidity increases the unwavering quality of shear wave elastography, making it a vital device in clinicians' decision-making processes.

Shear wave elastography has come about past absolute determination. Its noninvasive nature dispenses with the need for tissue inspection, diminishing patient distress and the hazard of surgery related to obtrusive strategies. Shear wave elastography gives prompt pictures, permitting a way better appraisal of tissue flexibility and response to outside boosts. This feedback can presently offer assistance in determining the cause of the lesions and the treatment plan, subsequently making strides in the by-and-large administration of breast lesions(Cheng et. al 2021)..

Challenges and Limitations

Despite its potential, numerous challenges and restrictions have anticipated the use of ultrasound elastography in clinical settings. A noteworthy challenge is modeling the elastography preparation. Contrasts in imaging methods, gadget settings, and information examination strategies can lead to conflicting opinions and reduce comparability. Strategies and methods should be actualized to guarantee consistency and reproducibility between imaging sites.

Operator changeability is another imperative issue influencing the unwavering quality of elastography estimations. Employees' information and abilities are imperative in visual collection, translation, and information examination Managers who could be more talented in their work may encounter picture issues, leading to mistakes concerning products that must be clarified. Safety arrangements and testing are critical to addressing staff turnover and ensuring the consistency of elastography testing (Altıntas et. al 2021).

A visual assessment of the elastography picture can be deceiving and conflicting since it depends on the portrayal of the question. Objective models and quantitative expectations are required to complement visual appraisal and empower the development of elastography. Inquire about almost everything that has been done recently. The translational demonstration and related thoughts are critical for the advancement of elastography.

Future directions

Looking forward, endeavors should be made to clarify these issues and advance the field of ultrasound elastography. Calibration, arrangement, and solidity testing are vital to guarantee the consistency and repeatability of elastography gauges. The encouraged investigation is additionally required to assess the value of elastography in particular patients and clinical circumstances. Technological progress can also help overcome current elastography restrictions. Propels in technology, data handling calculations, and machine learning strategies can extend the precision and productivity of elastography estimations (Reghunath et. al 2021). Future inquiries ought to center on utilizing these progresses to create unused strategies to survey breast lesions. In conclusion, ultrasound elastography, and especially shear wave elastography, appears to be an extraordinary guarantee as a vital help in the assessment of localized breast lesions. Despite the challenges and impediments, the benefits of evaluating intaglio tissue with elastography exceed the disadvantages. With continuous inquiry, modeling endeavors, and mechanical progress,

ultrasound elastography has the potential to revolutionize breast imaging and move forward with patient outcomes.

In summary, ultrasound elastography, particularly shear wave elastography, gives a great view of the tissue characterization of breast tissue within the locale past elastography in conclusion. Consolidating elastography into a clinical schedule will increase the accuracy of the conclusion of breast injuries while decreasing patient anxiety around pointless surgery. To realize its full potential, more inquiry is required to form a particular convention and make it more exact for distinctive patients (Wei et. al 2021). Tending to this inquiry about holes will broaden the use of ultrasound elastography and give doctors a noninvasive and compelling instrument for surveying breast lesions. At last, progress and changes in ultrasound elastography have the potential to revolutionize breast imaging, improving patient results and quality of care in breast cancer treatment.

Recommendations

Based on the findings of this investigation, a few proposals can be made for the use of ultrasound elastography in the assessment of breast lesions. Standard strategies ought to be set up to guarantee consistency across diverse areas. Moment, preparing, and proceeding with instruction are imperative to extend representative efficiency and minimize contrasts in elucidation. Third, future thinking should center on achievability studies and long-term results to assess the effect of ultrasound elastography on patient administration (Choi et. al 2021). Taking these recommendations into consideration, ultrasound elastography may be viable within the symptomatic stage of breast cancer and eventually lead to patient results.

REFERENCE

Cantisani, V., David, E., Barr, R. G., Radzina, M., de Soccio, V., Elia, D., ... & D'Ambrosio, F. (2021). US-elastography for breast lesion characterization: prospective comparison of US BIRADS, strain elastography and shear wave elastography. *Ultraschall in der Medizin-European Journal of Ultrasound*, *42*(05), 533-540. https://www.thieme-connect.com/products/ejournals/html/10.1055/a-1134-4937

Sinha, D., Sharma, S., Kundaragi, N. G., & Kale, S. K. (2020). Added value of strain elastography in the characterisation of breast lesions: A prospective study. *Ultrasound*, *28*(3), 164-173. https://journals.sagepub.com/doi/abs/10.1177/1742271X20912762

Reddy, J., & Khaladkar, S. M. (2021). Evaluation of focal breast lesions on ultrasound, color Doppler and real time elastography: A prospective study. *J Evidence Based Med Healthcare*, *8*, 146-50. https://www.academia.edu/download/63513556/IJRR00220200603-100852-zu60kk.pdf

Mutala, T. M., Mwango, G. N., Aywak, A., Cioni, D., & Neri, E. (2022). Determining the elastography strain ratio cut off value for differentiating benign from malignant breast lesions: systematic review and meta-analysis. *Cancer Imaging*, *22*(1), 12. https://link.springer.com/article/10.1186/s40644-022-00447-5

HAMED, S. T., BASMA, M. A., DALIA, S. E., & AHMED, N. M. E. (2021). The Value of Ultrasound Elastography in Evaluating Inflammatory Breast Lesions. *The Medical Journal of Cairo University*, *89*(June), 1289-1297. https://mjcu.journals.ekb.eg/article_185039.html

Wang, Y., Liu, Y., Zheng, X., Huang, Y., Han, J., Li, F., ... & Zhou, J. (2020). Added value of different types of elastography in evaluating ultrasonography detected breast lesions: a compared study with mammography. *Clinical breast cancer*, *20*(3), e366-e372. https://www.sciencedirect.com/science/article/pii/S1526820919307335

Ranjkesh, M., Hajibonabi, F., Seifar, F., Tarzamni, M. K., Moradi, B., & Khamnian, Z. (2020). Diagnostic value of elastography, strain ratio, and elasticity to B-mode ratio and color Doppler ultrasonography in breast lesions. *International Journal of General Medicine*, 215-224. https://www.tandfonline.com/doi/abs/10.2147/IJGM.S247980

Wang, B., Chen, Y. Y., Yang, S., Chen, Z. W., Luo, J., Cui, X. W., ... & Yi, A. J. (2022). Combined use of shear wave elastography, microvascular doppler ultrasound technique, and BI-RADS for the differentiation of benign and malignant breast masses. *Frontiers in Oncology*, *12*, 906501. https://www.frontiersin.org/articles/10.3389/fonc.2022.906501/full

Li, S. Y., Niu, R. L., Wang, B., Jiang, Y., Li, J. N., Liu, G., & Wang, Z. L. (2023). Determining whether the diagnostic value of B-ultrasound combined with contrast-enhanced ultrasound and shear wave elastography in breast mass-like and non-mass-like lesions differs: a diagnostic test. *Gland Surgery*, *12*(2), 282. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10005981/

Cheng, C., Wang, Y., Qin, H., Wang, J., Zhang, S., Teng, R., ... & Li, N. (2021). Combined diagnosis of ultrasonic elastography and BI-RADS classification increases diagnostic value in female patients with breast neoplasms. *American Journal of Translational Research*, *13*(10), 11758. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8581871/

Sune, S., Ambad, R., Jha, R. K., Jadhav, D., Dhawade, M. R., & Wankhade, Y. (2024). Comparative analysis of mammary lump histology and elasto-graphy results at a tertiary hospital. In *E3S Web of Conferences* (Vol. 491, p. 03004). EDP Sciences. https://www.e3s-conferences.org/articles/e3sconf/abs/2024/21/e3sconf_icecs2024_03004/e3sconf_icecs2024_03004.html

Altıntas, Y., Bayrak, M., Alabaz, Ö., & Celiktas, M. (2021). A qualitative and quantitative assessment of simultaneous strain, shear wave, and point shear wave elastography to distinguish malignant and benign breast lesions. *Acta Radiologica*, *62*(9), 1155-1162. https://journals.sagepub.com/doi/abs/10.1177/0284185120961422

Wei, Q., Yan, Y. J., Wu, G. G., Ye, X. R., Jiang, F., Liu, J., ... & Cui, X. W. (2021). Added value of a new strain elastography technique in conventional ultrasound for the diagnosis of breast masses: a prospective multicenter study. *Frontiers in Oncology*, *11*, 779612. https://www.frontiersin.org/articles/10.3389/fonc.2021.779612/full

Reghunath, A., Mittal, M. K., Chintamani, C., & Prasad, R. (2021). Novel approach in the evaluation of ultrasound BI-RADS 3 & 4 breast masses with a combination method of elastography & Doppler. *Indian Journal of Medical Research*, *154*(2), 355-366. https://journals.lww.com/ijmr/fulltext/2021/08000/Novel_approach_in_the_evaluation_of_ultrasound.21.aspx

Gu, Y., Tian, J., Ran, H., Ren, W., Chang, C., Yuan, J., ... & Jiang, Y. (2022). Can ultrasound elastography help better manage mammographic BI-RADS category 4 breast lesions?. *Clinical Breast Cancer*, *22*(4), e407-e416. https://www.sciencedirect.com/science/article/pii/S1526820921003001

Gil, B. M., Jung, N. Y., Kim, S. H., Kang, B. J., Lee, J., & Chung, M. H. (2022). Value of shear wave elastography during second-look breast ultrasonography for suspicious lesions on magnetic resonance imaging. *Journal of Medical Ultrasonics*, *49*(4), 719-730. https://link.springer.com/article/10.1007/s10396-022-01253-z

Choi, S. H., Ko, E. Y., Han, B. K., Ko, E. S., Choi, J. S., & Park, K. W. (2021). Effect of calcifications on shear-wave elastography in evaluating breast lesions. *Ultrasound in Medicine & Biology*, *47*(1), 95-103. https://www.sciencedirect.com/science/article/pii/S0301562920304348

Xue, S. S., Zhao, Q. L., Ruan, L. T., Wang, F. Q., Zhou, C., & Sheng, W. (2022). Comparative analysis of the quantitative parameter method and elasticity color mode method for real-time shear wave elastography in the diagnosis of benign and malignant solid breast lesions. *Tumori Journal*, *108*(6), 578-585. https://journals.sagepub.com/doi/abs/10.1177/03008916211048239

He, H., Wu, X., Jiang, M., Xu, Z., Zhang, X., Pan, J., ... & Chen, J. (2023). Diagnostic accuracy of contrast-enhanced ultrasound synchronized with shear wave elastography in the differential diagnosis of benign and malignant breast lesions: a diagnostic test. *Gland Surgery*, *12*(1), 54. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9906099/

Pu, H., Peng, J., Xu, F., Liu, N., Wang, F., Huang, X., & Jia, Y. (2020). Ultrasound and clinical characteristics of false-negative results in mammography screening of dense breasts. *Clinical Breast Cancer*, *20*(4), 317-325. https://www.sciencedirect.com/science/article/pii/S1526820920300446

Osman, O. A., Chalabi, N., & Salama, A. M. (2022). ROLE OF ULTRASOUND ELASTOGRAPHY IN THE ASSESSMENT OF INFLAMMATORY BREAST LESIONS. *Ain Shams Medical Journal*, *73*(2), 269-281. https://asmj.journals.ekb.eg/article_252399.html

Liu, W., Li, W., Li, Z., Shi, L., Zhao, P., Guo, Z., ... & Wang, Z. (2020). Ultrasound characteristics of sclerosing adenosis mimicking breast carcinoma. *Breast Cancer Research and Treatment*, *181*, 127-134. https://link.springer.com/article/10.1007/s10549-020-05609-2

Li, J., Wu, Y., Tian, Z., Shu, L., Wu, S., & Wu, Z. (2024). Application Value of Ultrasound Elastography Combined With Contrast-Enhanced Ultrasound (CEUS) Quantitative Analysis in Differentiation of Nodular Fibrocystic Changes of the Breast From Invasive Ductal Carcinoma. *Ultrasonic Imaging*, *46*(2), 102-109. https://journals.sagepub.com/doi/abs/10.1177/01617346231217087

Elia, D., Fresilli, D., Pacini, P., Cardaccio, S., Polti, G., Guiban, O., ... & Cantisani, V. (2021). Can strain US-elastography with strain ratio (SRE) improve the diagnostic accuracy in the assessment of breast lesions? Preliminary results. *Journal of Ultrasound*, *24*, 157-163. https://link.springer.com/article/10.1007/s40477-020-00505-3

Rabiey Mohammed, W., Mahmoud Zied, A., & Montaser Roshdy, H. (2021). VALUE OF BREAST ELASTOGRAPHY IN EVALUATION OF BREAST MASSES DETECTED ON SCREENING ULTRASOUND. *Al-Azhar Medical Journal*, *50*(2), 1539-1552. https://journals.ekb.eg/article_158640_0.html

Varshney, D. K., Mishra, R., Mishra, A. P., & Kumar, R. Comparative Evaluation of Ultrasound Elastography with Fine Needle Aspiration Cytology and Histopathological Examination of Breast Masses. https://www.researchgate.net/profile/Dushyant-Varshney-4/publication/378830961_Comparative_Evaluation_of_Ultrasound_Elastography_with_Fine_Needle_Aspiration_Cytology_and_Histopathological_Examination_of_Breast_Masses/links/65ec31259ab2af0ef8a977df/Comparative-Evaluation-of-Ultrasound-Elastography-with-Fine-Needle-Aspiration-Cytology-and-Histopathological-Examination-of-Breast-Masses.pdf

Wang, W., Zhang, J. C., Tian, W. S., Chen, L. D., Zheng, Q., Hu, H. T., ... & Ruan, S. M. (2021). Shear wave elastography-based ultrasomics: differentiating malignant from benign focal liver lesions. *Abdominal Radiology*, *46*, 237-248. https://link.springer.com/article/10.1007/s00261-020-02614-3

Guiban, O., Rubini, A., Vallone, G., Caiazzo, C., Di Serafino, M., Pediconi, F., ... & Vergine, M. (2023). Can New Ultrasound Imaging Techniques Improve Breast Lesion Characterization? Prospective Comparison between Ultrasound BI-RADS and Semi-Automatic Software "SmartBreast", Strain Elastography, and Shear Wave Elastography. *Applied Sciences*, *13*(11), 6764. https://www.mdpi.com/2076-3417/13/11/6764

Yıldız, M. S., Goya, C., & Adin, M. E. (2020). Contribution of sonoelastography to diagnosis in distinguishing benign and malignant breast masses. *Journal of Ultrasound in Medicine*, *39*(7), 1395-1403. https://onlinelibrary.wiley.com/doi/abs/10.1002/jum.15236

Barr, R. G. (2020). Breast elastography. *Tissue Elasticity Imaging*, 21-46. https://www.sciencedirect.com/science/article/pii/B9780128096628000024