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Role of Sonoelastography in Characterization of Solid Breast Lesions: Review Article

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ABSTRACT

Background: Breast cancer ranks as the most frequent cancer among women. Detecting it early can lessen the disease's severe outcomes and death rates. Sonoelastography has proven effective in identifying breast cancer at an early stage.

Objective: This article aimed to assess how well sonoelastography distinguishes between benign and malignant solid tumors in the breast.

Material and methods: Medline resources (including PubMed, Medscape, ScienceDirect, EMF-Portal) and all available online materials up to 2023 for Sonoelastography and Solid breast lesions (Malignant and benign). Studies not meeting the inclusion criteria were excluded. The quality assessment of studies considered factors like obtaining ethical approval, specifying eligibility criteria, having appropriate controls, and providing sufficient information and defined assessment measures.

Conclusion: Ultrasound elastography plays an important complementary role alongside traditional mammograms and ultrasounds in identifying solid breast lesions. Thus, this technique could aid in planning biopsies for lesions and preventing unnecessary procedures.

Keywords: Ductal carcinoma in situ, Ultrasound elastography, Strain elastography, Shear wave elastography.

INTRODUCTION

Skin cancers aside, breast cancer stands out as the most frequently diagnosed cancer in women within the United States, representing almost one-third of all cancer cases. Furthermore, it ranks as the second most prevalent cause of cancer-related mortality in women, following lung cancer [(1)]. The most commonly occurring cancerous growths were categorized into three distinct groups: ductal carcinoma in situ (DCIS), invasive ductal carcinoma of the non-scirrhous variety, and invasive ductal carcinoma of the scirrhous variety. Likewise, the most frequently observed non-cancerous growths were segregated into three subcategories: intraductal papilloma, fibroadenoma, and irregularities in the normal developmental and involution processes (ANDI) [(2)].

Over the last two decades, ultrasound imaging has seen significant improvements in quality. Nevertheless, diagnosing a breast mass remains a daily challenge for radiologists using ultrasound (US). This has led to the need for new diagnostic methods, including ultrasound elastography (UE) [(3)]. Elastography is based on the principle that tissue compression causes strain (displacement) within the tissue, with harder tissues exhibiting less strain than softer ones. By measuring the strain induced by compression, UE can effectively "visualize" tissue hardness, display its texture, and reveal the biological characteristics of the mass. This approach exhibits promising promise in discerning between benign and aggressive breast cancers [(2, 4)].

Contemporary ultrasound technology, which is readily available via commercial ultrasound machines, encompasses instruments that provide flexible, manually directed scanning, offering exceptional spatial resolution and little interference. In the context of tumor detection. It has been shown that benign growths tend to display consistent strain patterns. However, breast malignancies often exhibit a notable absence of strain, both inside the lesions themselves and in the surrounding tissue. Elastography has been acknowledged as a good tool in the discrimination of shadowing caused by fibrosis and shadowing resulting from malignancy [(5, 6)].

The combination of UE with traditional sonography and mammography presents a significant advancement in the assessment of two key aspects of a lesion: its shape and tissue stiffness. The aforementioned characteristics provide valuable insights into the intrinsic qualities of the disease, facilitating the distinction between benign and malignant tumors. The implementation of a multi-modal approach improves the sensitivity, specificity, accuracy, and positive predictive value, consequently boosting the diagnostic capabilities of sonomammography. The effectiveness of UE in the detection of breast cancer has been found to be notable in individuals with lower breast size, surpassing the diagnostic capabilities of conventional sonomammography methods. Furthermore, it has been observed that elastography demonstrates increased sensitivity in the context of breast lipomatous involution in comparison with standard B-mode ultrasonography [(7, 8)].

Nevertheless, it is crucial to acknowledge that sonoelastography does have notable limits. There exist additional factors that contribute to the challenges experienced in the field of elastography. Several factors contribute to the challenges associated with elastogram analysis. These factors encompass the operator's skill level, the subjective interpretation of elastogram outcomes, and the increased sensitivity to even slight adjustments in patient positioning [(9)].

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AIM OF THE WORK

The primary aim of this research was to evaluate the diagnostic efficacy of sonoelastography in differentiating between benign and malignant solid breast lesions.

REVIEW OF LITERATURE

Ultrasound elastography of the breast

Ultrasound elastography is a diagnostic tool utilized to assess the variations in stiffness or elasticity of lesions, a characteristic that was traditionally evaluated with manual palpation [(10)].

Types of ultrasounds elastography: Strain and real-time shear wave ultrasound elastography:

I. Strain ultrasound elastography

In the context of strain ultrasonographic elastography, the tissue experiences displacement as a result of the propagation of ultrasonographic waves. The generation of displacement is often accomplished through mechanical compression, which can be produced utilizing many methods such as the utilization of an ultrasonic transducer, manual longitudinal compression, or even through breathing motions. Nevertheless, it is crucial to acknowledge that this methodology largely facilitates a qualitative assessment of tissue deformation. The modality functions by quantifying the alteration in the radiofrequency of the ultrasound beam both prior to and subsequent to the implementation of compression [(11)]. The degree of compression applied is indicated by the magnitude of deformation along the longitudinal axis. Following this, the data pertaining to tissue deformation is transformed into an elastic modulus, resulting in the generation of an elastogram, which serves as a visual depiction of the tissue's elasticity. The adoption of this method is extensive as a result of its straightforwardness and independence from specialized software. However, it is lacking in terms of offering quantitative evaluations and significantly depends on the proficiency and technique of the operator [(12)].

Technique of strain sonoelastography

Patient position

To achieve optimal results in sonoelastography (SE), it's essential to ensure proper patient positioning. This involves aligning the transducer perpendicularly to the floor, and positioning the patient in a manner that their breathing induces movement of the lesion within the imaging plane. SE primarily assesses the relative stiffness of different tissues, so it's critical to include a variety of tissues within the field of view (FOV).

In the context of breast SE, this typically encompasses fat (which is the softest tissue), fibro-glandular tissue, the pectoralis muscle, and, of course, the lesion itself [(13)].

Technique

One crucial factor to take into account during breast elastography is the handling of pre-compression. When subjecting any substance to compression, such as breast tissue, there is an observed tendency for its stiffness to augment. In order to obtain precise elastography outcomes, regardless of whether strain or shear wave techniques are employed, it is imperative to employ minimal compression on the breast. In the context of conventional B-mode imaging, it is customary to employ a certain level of pre-compression to rectify Cooper's ligaments, hence mitigating the occurrence of imaging artifacts. Nevertheless, when it comes to strain elastography (SE), an overabundance of pre-compression might result in images that are characterized by high levels of noise. The utilization of mild to moderate pre-compression has the potential to yield a sequence of images that alternate between clarity and noise, with the clearer images predominantly occurring during the upward phase of the compression cycle.

In the context of serial spin echo (SE) images, the identification of discrepancies can generally suggest either an elevated degree of pre-compression or the movement of the lesion within the scanning plane. A potential method has been suggested to efficiently implement minimum pre-compression as a means of addressing this problem. In addition, it is crucial to ensure the consistent imaging plane of the lesion remains within the field of view (FOV) throughout the data acquisition process to get satisfactory spin echo (SE) images [(13)].

Interpretation of SE

Interpreting sonoelastography (SE) images of the breast involves considering three proposed methods: (i) Elastogram to B-mode length ratio (E/B ratio): This method assesses the size of the lesion as seen on the elastogram in relation to its size on B-mode imaging. By doing a comparison of these sizes, valuable information can be gained regarding the relative stiffness of the lesion in relation to its visual representation on standard B-mode imaging. (ii) The utilization of a 5-point color scale as a visual method to depict varying degrees of tissue stiffness. Different colors are employed to represent different levels of tissue elasticity, enabling a subjective evaluation of stiffness within the seen tissue. (iii) Strain ratio: The technique entails evaluating the relative stiffness of the lesion in comparison with the stiffness of neighboring adipose tissue, which is commonly denoted as the strain ratio. It quantitatively evaluates the relative hardness of the lesion by contrasting it with the well-known softness of fat tissue.

These three methods offer different ways to interpret SE images and provide valuable information about the characteristics of breast lesions [(13)].

E/B Ratio

The E/B ratio is employed as a method for assessing breast lesions by dividing the length of a lesion observed on elastography by its length observed on B-mode imaging. The correlation between this ratio and the level of aggressiveness exhibited by the malignancy has been firmly established. Less severe types of lesions, such as mucinous malignancies or ductal carcinoma in situ, typically demonstrate ratios of 1.0 or somewhat greater. Conversely, it has been noted that more aggressive lesions, such as invasive ductal carcinoma, may demonstrate ratios as high as 3 [(14)]. A threshold value below 1.0 has been employed to signify the presence of benign lesions, whereas a ratio equal to or over 1.0 indicates the presence of malignant lesions, hence providing a high level of sensitivity and specificity in the characterization of lesions [(13)].

Strain Ratio

Sonoelastography (SE) largely functions as a qualitative technique, lacking the ability to directly quantify tissue stiffness. In contrast, it evaluates the comparative rigidity of the tissue in relation to adjacent structures within the visual range. However, it is feasible to acquire a semi-quantitative evaluation of tissue stiffness by contrasting the stiffness of the particular lesion with that of a reference tissue [(15)]. In the context of breast structural engineering, it is normal practice to select adipose tissue as the reference material. The conventional method for doing this semi-quantitative evaluation involves the placement of a region of interest (ROI) within the lesion and another ROI in the surrounding adipose tissue. Subsequently, the ultrasound system computes a ratio of the stiffness values obtained from these two regions. The aforementioned ratio offers an estimation of the relative stiffness of the lesion in comparison with the reference tissue, hence providing a valuable understanding of its inherent properties.

It is crucial to acknowledge that diverse ultrasound systems may employ distinct techniques for assessing relative tissue strain, resulting in varying stiffness ratios across equipment from different manufacturers. In order to ensure accurate measurement, it is imperative to apply equal levels of stress to both the lesion and the reference tissue. Ideally, it is recommended to position the regions of interest (ROIs) at a consistent depth relative to the transducer.

In situations when adipose tissue is not accessible for reference, as observed in certain Asian women, it is possible to employ normal glandular tissue instead. However, it is important to note that the threshold values for describing lesions will vary from those employed when fat tissue is utilized as the reference standard. Various studies have found cutoff values ranging from 2.3 to 4.8 when utilizing fat as a reference to differentiate between benign and malignant breast tumors [(15, 16)].

Color scale of strain elastography

5-Point color scale

Various color maps are available for interpreting sonoelastography images, and the choice of map can significantly affect the ease of detecting subtle differences between tissues and identifying noise. The authors suggest that the grey scale map is particularly effective for these purposes. It's crucial to be aware of which color map is used, as different maps may represent stiffness differently, with some showing stiff areas as red and others as blue [(13)].

The utilization of the 5-point color scale is a technique employed to classify breast masses according to their attributes in sonoelastography. According to this scale, a score of 1 signifies that the lesion exhibits total softness. A score of 2 is assigned to the lesion if it demonstrates a confluence of both pliable and rigid elements. A lesion that exhibits rigidity and demonstrates a reduced size compared to its depiction on B-mode imaging is designated a score of 3. A grade of 4 is assigned to a lesion that exhibits rigidity and corresponds in dimension on B-mode imaging. In the context of lesion evaluation, a lesion that exhibits rigidity and surpasses its apparent size on B-mode imaging is assigned a score of 5 [(2)].

The Tsukuba scoring system, which was introduced by **Itoh *et al.*** [(2)], is a commonly employed approach within the field of strain ultrasound elastography. The color-coded system is derived from the comparative analysis of lesion size in B-mode ultrasonography and its corresponding representation in the elastogram image. Malignant lesions frequently exhibit greater dimensions in elastographic imagery. The present approach exhibits the stiffness or strain characteristics of lesion tissue through the generation of photographs that can be presented in either black-and-white or color-coded format. The scoring method employs a range of scores, ranging from 1 to 5, which are allocated depending on the subsequent set of criteria:

- **Score 1:** The lesion is completely deformable.
- **Score 2:** A large part of the lesion is deformable with some stiff areas.
- **Score 3:** The lesion has a stiff area in the center, but the periphery of the lesion is deformable.
- **Score 4:** The entire lesion is completely stiff.
- **Score 5:** Both the lesion and the surrounding area are stiff.

According to the Tsukuba scoring system, the elasticity results are categorized as negative (score 1), equivocal (scores 2–3), and positive (scores 4–5), providing a structured framework for interpreting the elastographic characteristics of breast lesions.

Image artifacts in sonoelastography

Blue/green/red artifact

Within specific ultrasound systems, a discernible artifact referred to as the blue/green/red artifact manifests itself in cysts, exhibiting a trichromatic pattern consisting of blue, green, and red hues, with blue denoting rigidity. As of present, a comprehensive investigation has not been conducted to evaluate the sensitivity and specificity of this artifact [(17)].

Bull's eye artifact

The presence of a Bull's eye artifact has been documented in simple and benign cysts by specific manufacturers, such as Siemens Ultrasound and Philips Ultrasound. The visual characteristics of this artifact exhibit variation when the cyst contains non-mobile components, resulting in a discernible flaw in the Bull's eye pattern [(18)].

Bang artifact

The "Bang" artifact, which is a region of high stiffness in the near field, can be observed in shear wave elastography when an excessive compression is applied using the transducer. The resolution of this matter can be achieved by reducing the pressure exerted by the transducer [(13)].

Worm artifact

The Worm artifact manifests when there is a limited range of elastic properties among the tissues within the field of view (FOV), resulting in a discernible pattern of fluctuating noise. The presence of this artifact may manifest when the FOV only encompasses a singular type of tissue or when substantial pre-compression is administered. The resolution of this problem can be attained by employing minimal pre-compression procedures and integrating a variety of tissue types into the FOV [(19)].

Sliding artifact

The identification of a soft ring or a grouping of wave-like soft rings encircling a lesion in sonoelastography (SE) indicates that the lesion is demonstrating movement both towards and away from the imaging plane during the acquisition of the elastogram. To effectively reduce the occurrence of this artifact, it is crucial to maintain a stable imaging plane on the lesion throughout the whole procedure of acquiring the elastogram. The presence of this artifact is commonly observed in conjunction with non-malignant growths such as fibroadenomas or lipomas, as it requires the autonomous displacement of the tumor from the adjacent tissues. In contrast, malignant lesions often exhibit a connection with neighboring tissues and therefore do not generally display this artifact [(13)].

II. Real-time shear wave elastography

The technique of real-time shear wave elastography enables the measurement of lateral tissue deformation and provides a direct assessment of the propagation of waves. The methodology utilizes a standard transducer to produce waves of pressure. Subsequently, a sequence of visual representations is captured with the intention of generating a meticulously designed beam [(20)]. Subsequently, the velocity of local propagation is quantified, and a two-dimensional representation is generated. The provided map presents a quantitative evaluation, wherein the stiffness values of tissues are depicted in kilopascals (kPa), thereby offering a numerical indication of tissue stiffness [(21)].

The utilization of color assessment in shear wave ultrasonic elastography, which involves the evaluation of maximal elasticity values measured in kilopascals (kPa), is considered a valuable technique. The risk of malignancy is positively correlated with the stiffness of the lesion, exhibiting a wide range of probabilities. Specifically, lesions with a dark blue color have a very low probability of 0.4%, while those with a red color have a significantly higher possibility of 81.8%. These items are classified into primary categories as outlined in previous studies [(22, 23)].

1. Lesions exhibiting soft flexibility, as seen by the presence of dark blue and light blue hues, are classified as negative.
2. Lesions exhibiting intermediate elasticity, denoted by the colors green and orange, are considered to be of uncertain interpretation.
3. Lesions with a firm elastic texture and characterized by a red appearance are considered to be indicative of a favorable condition.
4. Signal-void regions may manifest as either simple cysts or extremely firm masses [(24)].

Different clinical trials have proposed varying cutoff values, with a common range being around 50 kPa to differentiate benign from malignant lesions [(25)].

DISCUSSION

Elasticity, a crucial property of living tissues, requires a specific amount of force to induce elastic deformation. It is defined as the degree of lengthening a tissue undergoes in response to tension from a certain load. The elasticity of some masses can be assessed through physical examination. However, palpation alone is insufficient for evaluating elasticity in small or deeply situated lesions. Additionally, manual palpation is subjective. Sonoelastography, a novel ultrasound modality, assesses tissue consistency. Malignant tissues, often accompanied by extensive desmoplastic reactions, tend to be harder than benign tissues. On sonoelastography, these malignant tissues appear less elastic. Elastography is an imaging technology that has been specifically developed to evaluate the mechanical properties, particularly the stiffness, of soft tissues in a noninvasive manner. Sonoelastography facilitates the assessment of the disparity in hardness between healthy and diseased breast tissue by the measurement of tissue strain induced by probe compression. Several clinical studies have shown evidence of the potential of sonoelastography to differentiate between benign and malignant breast tumors [(26)].

B-mode sonography is an imaging modality that utilizes the principles of acoustic energy exchanges within the body to depict tissue intensity attributes as different levels of brightness on a screen. The generated images are rendered in grayscale and shown in a live, instantaneous manner. The utilization of this technique is prevalent in the determination of both the spatial positioning and internal composition of breast masses. B-mode sonography demonstrates a high level of sensitivity in the detection of malignant masses. Nevertheless, one significant limitation of this approach is its propensity to produce a substantial number of false positives. In order to tackle this matter, current scholarly investigations have directed their attention towards a more contemporary technique in the field of sonography, known as sonoelastography. This method seeks to enhance the precision of diagnoses by assessing the elasticity of tissues alongside the conventional B-mode imaging [(27)]. The utilization of elastography, employing both qualitative and quantitative methodologies, improves the effectiveness of regular B-mode ultrasonography. This enhancement is particularly evident in the increased specificity and accuracy of identifying uncertain breast lesions categorized as BI-RADS 3 and 4 [(28)]. Ascertained through the assessment of tissue rigidity and elasticity, sonoelastography has proven effective in distinguishing benign from malignant lesions. Pathological tissue typically experiences alterations in elasticity, which manifest as the development of rigid lesions that, in the case of malignant tumors, frequently adhere to adjacent structures. The aforementioned adherence eventually causes an increase in their hardness by causing a reduction in their overall activity and elasticity [(29)].

The significance of evaluating the efficacy of sonoelastography in comparison to traditional sonography and mammography in providing characterization data regarding solid breast lesions has been emphasized. The reason for this emphasis is the existence of contradictory results and the potential for inaccurate conclusions when attempting to differentiate benign from malignant breast lesions. The primary objective of this assessment was to decrease the occurrence of superfluous benign biopsies, while emphasizing its significance as a pivotal field of investigation. **Ghanem *et al.*** [(28)] conducted a prospective experiment involving a cohort of forty patients who exhibited palpable breast lesions. The lesions were accurately categorized as BIRADS 3 and 4a through the utilization of traditional mammography and ultrasonography techniques. The primary aim of this research investigation was to assess the effectiveness of sonoelastography relative to traditional mammography and sonography methods in identifying substantial breast lesions. The principal aim was to reduce the incidence of superfluous benign biopsies in cases involving both benign and malignant conditions. A total of 28 lesions, constituting 70% of the sample, underwent fine needle biopsy in this particular instance. On the contrary, the remaining twelve lesions, which accounted for 30% of the sample, were penetrated with a true cut needle. The histological examination unveiled that out of the total cases examined, 27 breast lesions (or 67.5%) were classified as benign. Furthermore, a total of nine lesions, which accounted for 22.5% of the cases, were classified as malignant. Atypia was observed in four lesions, which accounted for 10% of the cases. Moreover, according to the conclusive identification of breast lesions in the research conducted by **Ghanem *et al.*** [(28)], fibroadenoma was identified as the predominant benign breast lesion, accounting for 12 out of the total 27 benign lesions. Additionally, infiltrative ductal carcinoma was identified as the most frequent among malignant breast lesions, comprising 5 out of the 9 malignant cases. These findings underscore the significant complementary role of ultrasound elastography alongside conventional mammography and ultrasound in characterizing solid breast lesions.

In their study, ***Kalim et al.*** [(27)] conducted a descriptive cross-sectional investigation involving a cohort of 200 female patients who exhibited breast lumps that were believed to be malignant. The research revealed that 48% of the patients exhibited mammographic results that were suggestive of malignancy, namely falling under BI-RADS categories IV and V. In a similar vein, the application of elastography demonstrated malignancy (with scores of 4 and 5) in 96 instances, accounting for 48% of the total. The combination of sonoelastography and mammography resulted in the diagnosis of cancer in 112 cases, accounting for 56% of the total cases. Histopathological research definitively established the presence of cancer in 110 instances, accounting for 55% of the total cases examined. The sensitivity and specificity values for mammography were found to be 76.3% and 77.7% respectively, but for sonoelastography, the corresponding values were 77.3% and 87.7%. The utilization of both methodologies yielded enhanced outcomes, with a heightened sensitivity of 90.9% and specificity of 86.6%. The combined technique exhibited a diagnosis accuracy of 89%, surpassing the separate diagnostic accuracies of sonoelastography (82%) and mammography (77%). Furthermore, ***Ko et al.*** [(29)] emphasized that the utilization of Elastography could lead to a reduction in unnecessary biopsies. They conducted a retrospective analysis involving 34 breast lesions, revealing that 22 (65%) were benign, while 12

(35%) were malignant. In the context of elastography, of the 12 malignant lesions, two (16.7%) were incorrectly identified as negative. Specifically, one lesion initially categorized as BI-RADS category 4b turned out to be DCIS, and another classified as BI-RADS category 5 was identified as IDC. By employing Elastography to reclassify BI-RADS category 4a lesions as category 3, a remarkable 79% reduction in unnecessary biopsies could have been achieved among the 19 BI-RADS category 4a lesions. For these patients, a suitable course of action would involve a follow-up after 6 months, with no instances of cancerous lesions being overlooked.

Elkharbotly and Farouk [30] have underscored the significance of the lack of strain in a primary breast lesion identified with elastography as a critical element that augments the diagnostic precision of sonography. This improvement results in increased specificity and enables a more effective differentiation between benign and malignant focal abnormalities, especially in cases classified as BI-RADS 3 and 4. Consequently, the utilization of elastography led to a reduction in the occurrence of false-positive findings in breast diagnostics.

In a prior prospective research study conducted by ***Yerli et al.*** [26], the aim was to assess the utility of a scoring method in sonoelastography for distinguishing between benign and malignant solid breast masses. The present study included a sample size of 180 solid breast masses, which were observed in 155 patients. Among these, 147 masses were determined to be benign, while 33 were classified as malignant. The histological study of the lesions revealed that 147 instances (81.7%) exhibited benign diseases, whereas 33 cases (18.3%) displayed malignant characteristics. Among the benign lesions, there were 84 fibroadenomas, 34 fibrocystic disease cases, 7 papillomas, 6 fibro-adeno-lipomas, 4 instances of intraductal epithelial hyperplasia, 5 lipomas, 5 cases of stromal fibrosis, and 2 chronic mastitis cases. On the other hand, the malignant lesion group comprised 26 invasive ductal carcinoma cases, 4 lobular invasive carcinoma cases, and 3 ductal carcinomas in situ cases. The mean scores derived from sonoelastography were 2.61 ± 0.62 for benign lesions and 3.73 ± 0.69 for malignant lesions. The diagnostic parameters for B-mode sonography were found by setting a cutoff point between scores 3 and 4. These parameters include an accuracy of 81%, sensitivity of 89%, specificity of 79%, positive predictive value of 46%, and negative predictive value of 97%. In comparison, the use of the sonoelastographic scoring system yielded similar results of 87% for accuracy, 73% for sensitivity, 91% for specificity, 69% for positive predictive value, and 92% for negative predictive value. Therefore, the implementation of the 5-point scoring system in sonoelastography seems to function as an additional technique that improves the accuracy in distinguishing between benign and malignant solid breast masses.

Another research team conducted a prospective investigation including a cohort of 155 patients diagnosed with solid breast tumors. The objective of this study was to assess and evaluate the diagnostic efficacy of two different methods, namely a 5-point scoring system and strain ratio-based sonoelastography, in the evaluation of these lesions. Throughout the duration of their investigation, the researchers successfully identified and categorized a collective sum of 187 abnormalities within the cohort of 155 subjects who were subjects of examination. Among the aforementioned lesions, a total of 130 were identified as benign, and the remaining 57 were classified as malignant. Malignant lesions had notably higher mean scores (1.62 ± 0.69 vs. 4.07 ± 0.26, $P < 0.05$) and strain ratios (2.06 ± 1.27 vs. 6.66 ± 4.62, $P < 0.05$) in comparison with benign lesions. The area under the curve (AUC) was determined for both the 5-point scoring system and the strain ratio-based elastographic analysis. The AUC values were found to be 0.892 and 0.909, respectively. Statistical analysis indicated that there was no significant difference between these values, since the p-value was more than 0.05. For the 5-point scoring system, the sonoelastography approach demonstrated a sensitivity of 84.2%, specificity of 84.6%, accuracy of 84.5%, positive predictive value of 70.6%, and negative predictive value of 92.4%. On the other hand, when utilizing a cutoff point of 3.06 for the strain ratio, the sensitivity, specificity, accuracy, positive predictive value, and negative predictive value were found to be 87.7%, 88.5%, 88.2%, 76.9%, and 94.3%, respectively ($P > 0.05$). Indeed, the study indicates that both the 5-point scoring system and the strain ratio have comparable diagnostic performance. Moreover, the strain ratio may offer an advantage in cases where it is challenging to make judgments based on the 5-point scoring system in sonoelastographic images, as it can potentially provide a more objective means of distinguishing between masses [31].

CONCLUSION

Ultrasound elastography plays a significant complementary role alongside conventional mammography and ultrasound when it comes to characterizing solid breast lesions. As a result, this method can be valuable in the planning of biopsies for these lesions and can help in avoiding unnecessary procedures.

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