Original Article

ISSN (0): 2347-338X; ISSN (P): 2347-3371

Evaluating the Role of Virtual Touch Imaging in Differentiating Benign and Malignant Breast Lumps in Patients of Varying Age Groups

Anjali Sharma[1], Yamini Rohilla[2], Bushra Gulfam[3], Kashifa Chauhan[4], Mohd Abdullah Siddiqui[5]

[1-4]M.Sc. Medical Imaging Technology 2nd Year, Department of Paramedical Sciences, Jamia Hamdard, New Delhi, India.

[5]Clinical Instructor, Department of Paramedical Sciences, Jamia Hamdard, New Delhi, India

Abstract

Background: Virtual Touch Imaging Quantification (VTIQ), a shear wave elastography technique, provides a non-invasive method to assess tissue stiffness and may aid in distinguishing benign from malignant breast lesions. This study aimed to evaluate the diagnostic accuracy of VTIQ in differentiating breast lumps, in correlation with histopathology, across a broad female population. **Subjects and Methods:** A prospective observational study was conducted at Col Pant's Imaging Centre, New Delhi. A total of 160 female patients aged 18–70 years with sonographically evident breast lumps ≥4 mm was enrolled. All underwent B-mode ultrasonography and VTIQ elastography. VTIQ results were correlated with BI-RADS classification and histological findings. Descriptive and inferential statistical analyses were performed to assess diagnostic significance. **Results:** The majority of patients were in the 45–53 age group (26.2%). Of the 160 lesions, 81 (50.6%) were in the left breast and 75 (46.8%) in the right. Most lumps (77.5%) were non-palpable. VTIQ values >5 m/s were observed in 81.8% of BI-RADS 4 lesions, correlating strongly with histologically confirmed malignancies. Conversely, BI-RADS 2 and 3 lesions predominantly showed VTIQ values <5 m/s, indicating benign pathology. This suggests VTIQ's utility in reducing unnecessary biopsies in low-risk cases. **Conclusion:** VTIQ elastography demonstrates strong correlation with BI-RADS and histological outcomes, offering a valuable adjunct to conventional ultrasonography in breast lump evaluation. Its ability to stratify lesions based on stiffness enhances diagnostic confidence, potentially reducing invasive procedures in benign cases.

Keywords: Virtual Touch Imaging Quantification, VTIQ, breast lumps, elastography, USG, BI-RADS, shear wave, benign, malignant, diagnostic imaging.

Corresponding Author: Mohd Abdullah Siddiqui, Clinical Instructor, Department of Paramedical Sciences, Jamia Hamdard, New Delhi, India. Email: mas15sep@gmail.com

Received: 19 March 2025 **Revised: 03 May 2025** **Accepted: 29 May 2025** **Published: 30 June 2025**

Introduction

Among the growing worldwide population, breast cancer has emerged as the one of the most frequent cancers among women. Breast cancer is the world's 2ND most diagnosed cancer, trailing only lung carcinoma. [1] In India, cervical cancer is formerly dominated the landscape of women's health issues. however, new research show that breast cancer is become more frequent cancer, particularly in the metropolitan areas and among younger women. [1] A crucial contributing factor to this disturbing the trend is a lack of breast health knowledge and education, especially the practice of breast self-examination. This is the problem faces particularly acute in rural population, where access to healthcare and screening facilities are restricted. [1]

Accurately distinguishing between suspicious (malignant) from non- suspicious (benign) breast lumps are still the major medical challenge. The prognosis of patients is greatly impacted by the accurate and early diagnosis, which help in treatment and reduces the need for drastic measures. The Conventional diagnostic techniques, like mammography and B-mode ultrasound, have shown promise but are frequently inadequate when used alone. These techniques could need the necessitate confirmation tests such as core needle biopsies or fine needle aspiration cytology (FNAC), which is the invasive techniques but effective. These techniques are also creating severe anxiety in patients, raise healthcare expenses, and postpone the starts of the treatment. [2]

1.1 Ultrasound

The manifestation and identification of breast anomalies are significantly influenced by age (mammography or ultrasound). Age-specific diagnostic approaches are also required because breast cancer features differ among age groups. For example, because of its great sensitivity in identifying calcifications and masses in fatty breast tissue, mammography is the gold standard for breast cancer screening in women 40 years of age and older. [3] However, because younger women tend to have denser breast tissue, its diagnostic value decreases. Dense breasts may cause misleading negative results on mammograms by obstructing the view of malignancies. Ultrasound (USG) becomes a better option in certain situations.

In contrast to mammography, ultrasound imaging work with high-frequency sound waves to produce real-time images of the breast tissue without subjecting the patient to ionizing radiation. [4] This makes it a more comfortable and safe choice, particularly for younger groups that use it frequently. Diagnostic ultrasonography employs a transducer to send and receive sound waves at frequencies between 2 to 18 MHz, which are much beyond human hearing. [4] Grayscale visuals are created from the reflected sound waves and shown on the monitor. The kind, frequency, and tissue properties of the transducer all affect the image quality and penetration depth. [5]

1.1.a Breast Ultrasound

The goal of breast ultrasonography is to assess the breast's structural makeup and structure, including the parenchyma and surrounding adipose tissue. It helps distinguish between solid and cystic tumors, these features making it a useful supplement to mammography and clinical examination. [6] ultrasound is non-invasive and performs better for dense breast tissue, it is more frequently used imaging modality in younger women. The Siemens Acuson Sequoia ultrasound system, which is renowned for its sophisticated imaging capabilities and integration with elastography tools, was used in this work to do breast imaging in Col pant's imaging center as shown in fig.

Figure 1.1: Ultrasound Machine (Col pant's Imaging Center) Siemens Acuson Sequoia ultrasound system

1.2 Shear Wave Elastography (VTIQ)

Conventional ultrasound and mammography both offer crucial anatomical information, but they occasionally lack the specificity needed to distinguish between non-suspicious (benign) and suspicious (malignant) with certainty. Advanced imaging modalities like Virtual Touch Imaging Quantification (VTIQ) in shear wave elastography have been developed in response to this issue. [7]

VTIQ is one type of shear wave elastography, which analyzes the velocity of mechanically generated shear waves as they pass through tissue to determine the tissue stiffness. Benign are usually softer, while malignant are usually more rigid because of the dense cellular structure and desmoplastic response linked to cancer.[8] Both qualitative (color-coded stiffness maps) and quantitative (numerical SWS values) analysis of breast lesions are made possible by VTIQ's ability to quantify shear wave speed (SWS).[9] There is a patient's image that show the VTIQ value.

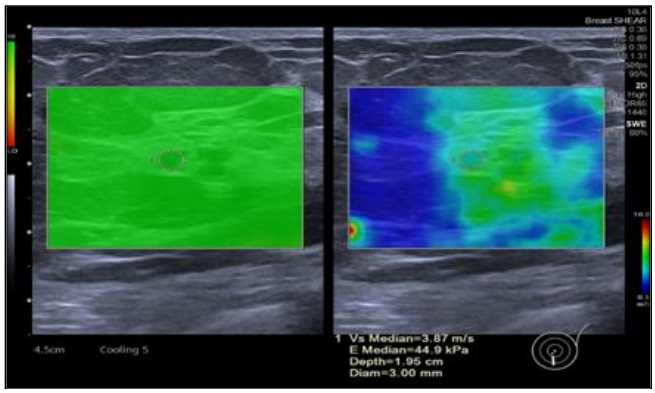

Figure 1.2: Elastography VTIQ value (less then 5m/s)

By superimposing elastography data on standard B-mode ultrasound pictures, this method improves diagnostic confidence by providing a more thorough view of the lesion in question. In addition to being non-invasive, repeatable, and operator-independent, VTIQ greatly enhances diagnostic consistency in a range of clinical contexts. In situations where normal imaging may not be sufficient, its usefulness is especially noticeable in younger women and those have dense breast. [10]

virtual imaging touch is more helps in healthcare organizations optimize their resources and improve the patient outcomes by lowering the invasive treatments like biopsies. Furthermore, it may be integrated into standard diagnostic workflows because to its real-time tissue characteristic identification capabilities. [11]

1.3 BIRADS

The American College of Radiology developed the Breast Imaging Reporting and Data System (BI-RADS), which provides a standardized framework for interpreting and reporting breast imaging results. The BI-RADS classifications, which range from 0 (incomplete) to 6 (biopsy-proven malignancy), allow clinicians to stratify patient risk and select the appropriate therapeutic courses. [12] Despite its extensive use, BI-RADS remains somewhat subjective and may not be as precise in cases of dense breast tissue or tumors with overlapping characteristics.

Integrating VTIQ with BI-RADS measurements significantly improves diagnostic specificity. In contrast to a lesion with low stiffness, which may warrant more careful treatment, a BI-RADS 3 (probably benign) lesion with a high shear wave speed on VTIQ may necessitate further follow-up or biopsy. This is especially useful in borderline or doubtful instances, when imaging ambiguity may make clinical decisions more difficult.

The goal of this study is to prospectively evaluating the VTIQ's efficacy as a non-invasive diagnostic tool for discriminating between non- suspicious (benign) and suspicious (malignant) breast lumps. We intend to develop

VTIQ as a reliable addition to standard imaging by investigating tissue elasticity and determining a link between shear wave speed and histological results. In addition to enhancing the chances of early breast cancer detection, understanding these characteristics aids in treatment planning, reduces unnecessary biopsies, and reduces patient anxiety. Incorporating cutting-edge imaging technologies like VTIQ into standard screening and diagnostic procedures may become more and more crucial for holistic, patient-centered treatment as the prevalence of breast cancer rises worldwide.

Need of the Study

Breast cancer remains a major health concern, with early diagnosis being critical for improving outcomes. Conventional ultrasound, though widely used, often struggles to accurately distinguish between benign and malignant lesions, leading to unnecessary biopsies. Virtual Touch Imaging Quantification (VTIQ), a shear wave elastography technique, offers a non-invasive method to assess tissue stiffness—an important indicator of malignancy. This study is needed to evaluate the effectiveness of VTIQ in improving diagnostic accuracy across different age groups, especially in younger women with dense breast tissue. By validating its role, VTIQ may help reduce unnecessary interventions and support better clinical decision-making.

Hypothesis

Null Hypothesis (H_0): There is no significant difference in VTIQ values between benign and malignant breast lumps across different age groups.

Alternative Hypothesis (H_1): There is a significant difference in VTIQ values between benign and malignant breast lumps, and VTIQ can be used as a reliable imaging modality to differentiate them across various age groups.

Aim of the Study

To investigate the correlation between Virtual Touch Imaging Quantification (VTIQ) values and the differentiation of benign and malignant breast lumps in patients undergoing breast ultrasound examination across varying age groups.

Objectives

- To examine both palpable and non-palpable breast lumps using VTIQ.
- To categorize breast lumps based on their stiffness and density.
- To evaluate Virtual Touch Imaging features in identifying and predicting suspicious and non-suspicious breast lumps.
- To reduce unnecessary breast biopsies by improving imaging-based differentiation of breast lesions.

Subjects and Methods

The purpose of this prospective observational study was to determine how well Virtual Touch Imaging Quantification (VTIQ) distinguishes between benign and malignant breast lumps. The primary objective was to evaluate the diagnostic efficacy of VTIQ in women of different ages who presented with breast abnormalities. Based on their mechanical characteristics, virtual touch imaging, an elastography technology, offers a non-invasive way to measure tissue stiffness and can assist in distinguishing between benign from malignant lumps. The study aimed to ascertain the validity of VTIQ in clinical decision-making for breast lesions by comparing these imaging findings with histological findings.

Study description

The study was carried out at Col Pant's Imaging Centre, a reputable diagnostic center with state-of-the-art imaging technology and a large patient volume, situated in Greater Kailash I, New Delhi. This site was chosen because it is easily accessible to a large population, guaranteeing a representative sample of Delhi's metropolitan female population. To ensure consistency in equipment, imaging methods, and interpretation, all processes—including patient recruiting and imaging—were carried out at this one location.

Written informed permission was obtained before participants were enrolled. A thorough ultrasound examination of the breast, including Virtual Touch Imaging, was performed on each subject. Cross-examination of prior mammography or ultrasound records for comparative analysis was part of the study design. All eligible patients who presented with breast lumps and were willing to participate were assessed throughout this time in accordance with the research protocol.

The G*Power 4.1 program was used to determine the study's sample size. The necessary minimum sample size was found to be 128 in order to attain a medium effect size (Cohen's d = 0.5), a significance level of 0.05, and a statistical power of 80% (0.80). However, the final sample size was raised to 160 patients in order to account for potential dropouts and guarantee improved representation and robustness of results. These individuals were chosen at random from among those who satisfied the inclusion requirements and came to the imaging in Col pant’s imaging center with routine checkup and breast-related concerns.

To ensure that the study focused on individuals for whom VTIQ testing would be clinically relevant and practical, the inclusion criteria were carefully defined. Adult female patients ranging in age from 18 to 70 years were included. Every participant had identifiable breast masses larger than 4 mm in diameter, which were discovered either clinical examination or previous imaging procedures such as ultrasonography or mammography. Only people who agreed to undergo a biopsy or fine needle aspiration cytology (FNAC) for histological confirmation were considered. Additional inclusion criteria included the availability of previous imaging data and a willingness to participate with informed consent.

Exclusion criteria were established to promote consistency in imaging interpretation and patient safety. Pregnant and nursing women were excluded because physiological changes in breast tissue could interfere with elastography evaluation. Patients with small lesions (<5 mm) or deep tumors that could not be accurately assessed by VTIQ were

eliminated. Individuals with biopsy contraindications, such as coagulopathies or other medical conditions, were also excluded. Furthermore, the study excluded participants who had breast implants or were unable to adhere to the imaging technique and follow-up requirements.

Statistical Analysis

Data were examined using descriptive and inferential statistical methods. Descriptive statistics were initially employed to summarise the data's main qualities. These included computing statistics such as mean, median, standard deviation, and range to depict the dataset's central patterns and variability. This stage provided a valuable overview of the sample distribution and overall trends in the collected data.

Following that, inferential statistics were used to draw conclusions and test hypothesis about the larger population based on the sample data. Using these statistical tools, the researchers determined whether the observed differences in VTIQ values between benign and malignant lesions were statistically significant. Comparative tests such as t-tests or Mann-Whitney U tests were used depending on the distribution of the data. The relationships between imaging data and histology findings were investigated in order to assess diagnostic accuracy, sensitivity, and specificity.

Results

This study looked at a group of patients with palpable and non-palpable breast lumps using shear wave elastography VTIQ features. The overall number of cases is 174, with 160 patients assessed utilizing VTIQ and standard B-mode ultrasonography,14 cases not included in VTIQ evaluation due to not proper VTIQ values mentioned and size of lump less than 4mm. The data were evaluated for Age group, Breast, Palpability, clock axis, Shear wave elastography VTIQ, and BIRADS categorization.

Table 1.1: Number of patients in age group

AGE GROUP	FREQUENCY (NO OF PATIENT)	PERCENTAGE
18-26	13	8.12
27-35	19	11.8
36-44	37	23.1
45-53	42	26.2
54-62	32	20.0
63-70	17	10.6

The 160 patients who underwent an ultrasound, they were separated into six age groups (18-26, 27-35, 36-44, 45-53,54-62 and 63-70). According to the separated age group, in the (18-26) age group, about 13 (8.12%) patients have done their ultrasound, (27-35) age group about 19 (11.8%) patients, (36-44) age group, about 37 (23.1%) patients, (45-53) age group, about 42 (26.2%) patients, (54-62)age group, about 32 (20%) patients, and (63-70) age group, about 17 (10.6%) patients, as shown in Fig 1.3. The mean age of having breast ultrasound is 46. Most of the women had USG in between age about 45 -53 age group. In the age group only 29 individuals had a documented family history of breast carcinoma, representing that approximately 18.1 % of total taken population for the study. [Table 1]

These analyzed instances, which included 81 (50.6%) patients involving the left breast, 75(46.8%) involving the right breast, and 4 (2.5%) involving both breasts, and their values were taken that had a higher VTIQ value are provided in the table. They are analyzed to determine the distribution and features across the various axis of the breast. This distribution pattern of breasts provides insights into diagnostic techniques, screening, and treatment planning in patients with breast abnormalities. [Figure 1]

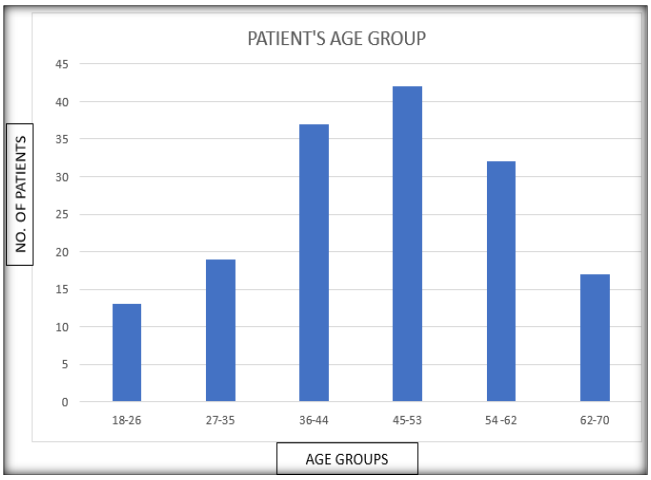

Figure 1.3: (NO. of patients in separated age group)

Table 1.2: Number of patients diagnosis breast

BREAST	RIGHT BREAST	LEFT BREAST	BOTH BREAST
NO. OF PATIENTS	75	81	4

Distribution of Palpability and the axis

The 124(77.5%) patients have non-palpable breast lumps, whereas 37(23.1%) have palpable breast lumps on clinical evaluation. The palpable breast lumps were regularly discovered in the different age range (18- 61 aged) and were easily diagnosed by routine screening and imaging. The Palpable breast lumps were typically larger, measuring more than 10mm in at least one dimension, and were associated

with more clinical concern. The palpability of the lumps did not necessarily correlate with higher BI-RADS scores, underlining the need for improved diagnostic imaging methods, such as VTIQ.

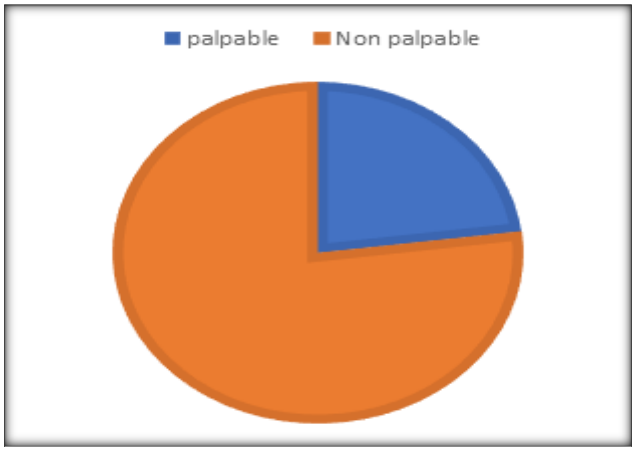

Figure 1.4: palpable / Non palpable Lumps

The axis of the breast indicates the proper location of the different types of lumps, which aids in the investigation of many lumps in the same breast. Among the 160 patients taken for this study, each has a particular axis lump that indicates their proper destination. There are 20(12.5%) patients in the 9'O clock axis, 15 (9.3%) in the 10'O CLOCK axis, 16 (10%) in the 11'O clock axis, 24 (15%) in the 12'O clock axis, 14 (8.7%)in the 1'O clock axis, 24 (15%) in the 2'O clock axis, 13 (8.1%) in the 3'O clock axis, 8 (5%) in the 4'O clock axis, and 4 (2%) in the 5'O clock axis, 9(5.6%) in the 6'Oclock axis, 10 (6.2%) in the 7'O clock and 4 patients in the 8'O clock axis. Most the lumps that investigate with b-mode ultrasound are present in 12'O clock axis and 2'0 clock in different breast.

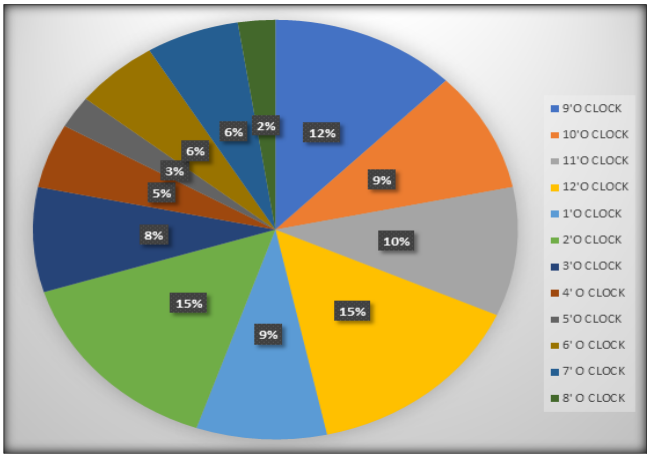

Figure 1.5: Different breast clock axis of lumps present

Reliability of virtual touch imaging with BI-RADS

VTIQ elastography gives a non-invasive measure of tissue stiffness, with greater readings in 5m/s often indicating increased stiffness and a potential indicator of suspiciousness. The VTIQ value provides useful grayscale overlays for lesion stiffness. There are 33 patients who have breast ultrasonography and have the impression of BI-RADS4, and one patient has BI-RADS5. The VTIQ value in BI-RADS4 shows intense coloration, suggesting excessive stiffness. The VTIQ also enabled the viewing of a known marker of suspicious mass (malignancy). In 27 (81.8%) out of 33 BI-RADS4 patients, the VTIQ value was greater than 5m/s.

Table 1.3 VTIQ values

BIRADS	VTIQ VALUE	
	0-5m/s	5-10m/s
BIRADS1	1	0
BIRADS2	47	0
BIRADS3	76	2
BIRADS4	6	27
BIRADS5	0	1

In contrast, non-suspicious BI-RADS2 and BI-RADS3 frequently demonstrated uniformity with limited color saturation. The BI-RADS3 Impression for patients with VTIQ less than 5m/s is 76 cases, and 2 individuals with VTIQ greater than 5m/therefore Follow-up imaging was advised, but biopsies were ultimately judged unnecessary after stable imaging on repeat follow-up. The BI-RADS2 patients had a VTIQ score less than 5 in 47 cases, indicating stable non-suspicious masses(benign).

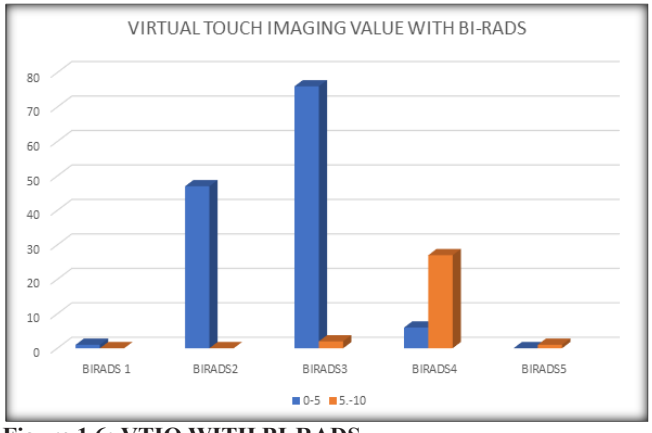

Figure 1.6: VTIQ WITH BI-RADS

A clear relationship exists between VTIQ values and BI-

RADS. The majority of BIRADS 2 and 3 had VTIQ score less than 5m/s, but BIRADS 4 and higher were highly related with score greater than 5m/s. This alignment promotes the use of shear wave elastography (VTIQ) as a supplemental diagnostic technique to regular breast ultrasound, which improves lump stratification. The Combining uses of shear wave elastography (VTIQ) measurements with ultrasound imaging minimizes unnecessary intervention. Clinically, VTIQ readings may lead to a more confident decision to monitor rather than do urgent biopsies or FNAC in low-risk patients.

Discussion

This study examined the diagnostic role of the Virtual Touch Imaging (VTIQ) in identifying benign from malignant breast lumps in 160 participants of varying ages. The majority of subjects had BIRADS 3—a category noted for its diagnostic uncertainty—and most VTIQ readings were about 5 m/s.

Our findings suggest the use of VTIQ as a supplemental imaging modality to B-mode ultrasound for boosting diagnostic precision. Specifically, suspicious (malignant) tumors had higher shear wave velocities than benign ones, with most malignant instances above the 5m/s threshold. Golatta et al. (2013) found that typical parenchyma has a mean VTIQ of 3.23 ± 0.74 m/s and fatty tissue around 2.5 ± 0.61 m/s, indicating that values approaching or exceeding 5 m/s are significantly higher than normal tissue stiffness ranges.

When comparing age groups, we found that elderly patients (>50 years) had greater VTIQ levels associated with malignancy, possibly due to postmenopausal changes and increased fibrosis within tumors. Younger patients (<40 years) with benign lesions, such as fibroadenomas, may have increased VTIQ, resulting in false positives. Golatta et al. also reported some stiffness overlap between benign and malignant tumors. Thus, patient age and lesion characteristics remain critical for appropriate interpretation. The grouping of instances within BIRADS 4 highlights the practical importance of VTIQ in this group. Given that BIRADS 4 lesions have a broad malignancy risk spectrum (2%-95%), using VTIQ scores may aid in risk stratification. Lesions with borderline grayscale characteristics and VTIQ <3.5 m/s can be watched instead of biopsied, but those with VTIQ >5 m/s may require immediate histological investigation.

Despite the promise displayed, certain restrictions must be addressed. First, interobserver variability can impair the consistency of VTIQ measures, however this has been reduced through standardized techniques. Second, lesion depth and breast density can alter velocity values. Interestingly, Golatta et al. discovered that breast density (ACR 1+2 vs ACR 3+4) had no significant effect on VTIQ readings, demonstrating its consistency across tissue types.

Another worry is measurement reliability, since Golatta et al. found a moderate interclass correlation (ICC = 0.52) showing variability even with repeated measures. This emphasizes the importance of multi-modality interpretation and future integration with AI to reduce subjective variability.

Finally, our findings confirm that VTIQ is an effective supplementary tool, particularly in BIRADS 4 lesions where distinction is crucial. When read in the context of age, grayscale ultrasonography, and clinical symptoms, a VTIQ value of 5 m/s or above elevates the possibility of cancer. Compared to the recognized normal ranges reported by Golatta et al., our data further justify the diagnostic role of VTIQ in routine breast imaging processes.

Conclusion

In this study, the efficacy of VTIQ imaging technique in detecting breast lumps in breast patients is investigated. The association between virtual touch and BI-RADS was investigated. Shear wave elastography (VTIQ) is a non-invasive and simple technology for clinical examinations. This is a real-time imaging technique that can be performed at the bedside alongside the B-mode assessment with ultrasound. In the case of breast cancer, shear wave elastography (VTIQ) is a high potential and with good diagnostic performance, according to various studies.

Our findings demonstrated that a measured VTIQ value is a useful supplement to the conventional b-mode ultrasound. This technique ability is to provide quantitative information on tissue stiffness while improving diagnostic accuracy, in between non- suspicious (benign) and suspicious (malignant) lumps. The suspicious lumps (Malignant) have much higher VTIQ values is about 81.8% (greater than 5m/s VTIQ values) due to increased cellular density and altered tissue architecture. In contrast to non- suspicious (benign)lumps, which often has a smaller value (less than 5m/s), reflecting its soft and elastic nature.

In the conclusion of the study, evaluating of VTIQ values in ultrasound supports their potential for reliable and efficient breast assessment. This technique provides quantitative data that can improve diagnostic confidence, particularly in distinguishing between suspicious and non- suspicious breast. Using this shear wave elastography (VTIQ) with B-mode ultrasound avoids the unnecessary biopsies investigation for the non-suspicious breast lumps.

References

1. "Dhillon PK, Mathur P, Nandakumar A, et al. The burden of cancers and their variations across the states of India: The Global Burden of Disease Study 1990–2016. Lancet Oncol. 2018;19(10):1289–1306. PMID: 30219626".
2. Saxena S, Rekhi B, Bansal A, et al. Clinico-morphological patterns of breast cancer including family history in a New Delhi hospital, India—A cross-sectional study. World J Surg Oncol. 2005;3:67. PMID: 16371159".
3. "Sickles EA. The use of breast imaging to screen women at high risk for cancer. Radiol Clin North Am. 2010;48(5):859–78. PMID: 20868893".
4. "Kelly-Fry E, Kopans DB, Halpern E. The frequency dependence of gray scale ultrasound tissue differentiation: A study of normal breast parenchyma. Invest Radiol. 1987;22(1):54–8. PMID: 3793794".
5. "Berg WA, Bandos AI, Mendelson EB, et al. Ultrasound as the primary screening test for breast cancer: Analysis from ACRIN 6666. J Natl

Cancer Inst. 2016;108(4):djv367. PMID: 26883203".
6. "Chang JM, Moon WK, Cho N, et al. Clinical application of shear wave elastography in the diagnosis of benign and malignant breast diseases. Breast Cancer Res Treat. 2011;129(1):89–97. PMID: 21336503".
7. "Zhou J, Zhan W, Chang C, et al. Breast lesions: Evaluation with shear wave elastography, with special emphasis on the "stiff rim" sign. Radiology. 2014;272(1):63–72. PMID: 24687191".
8. "Liu H, Zhan Y, Wan WB, et al. Conventional US and 2-D shear wave elastography of virtual touch tissue imaging quantification: Correlation with immunohistochemical subtypes of breast cancer. Ultrasound Med Biol. 2019;45(10):2612–22. PMID: 31474417".
9. "Yin L, Xie X, Zhang X, et al. Evaluation of virtual touch tissue imaging quantification, a new shear wave elastography, for differential diagnosis of breast lesions. PLoS One. 2014;9(4):e93906. PMID: 24718572".
10. "Evans A, Whelehan P, Thomson K, et al. Quantitative shear wave ultrasound elastography: Initial experience in solid breast masses. Breast Cancer Res. 2010;12(6):R104. PMID: 21143815".
11. "Lee SH, Chang JM, Kim WH, et al. Differentiation of benign from malignant solid breast masses: Comparison of 2D and 3D shear-wave elastography. Eur Radiol. 2013;23(4):1015–26. PMID: 23052456".
12. "Gweon HM, Youk JH, Son EJ, Kim JA. Clinical application of qualitative assessment for breast masses in shear-wave elastography. Eur J Radiol. 2013;82(11):e680–5. PMID: 23948585".

How to cite this article: Sharma A, Rohilla Y, Gulfam B, Chauhan K. Evaluating the Role of Virtual Touch Imaging in Differentiating Benign and Malignant Breast Lumps in Patients of Varying Age Groups. Asian J. Med. Radiol. Res. 2025;13(1):1-7.

DOI: dx.doi.org/10.47009/ajmrr.2025.13.1.1

Source of Support: Nil, Conflict of Interest: None declared.