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Role of Ultrasound Elastography in the Evaluation of Axillary Lymph Nodes in Patients with Breast Cancer

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ABSTRACT

Background: Breast cancer is the commonest cancer in women all over the world and the second commonest cause of malignancy-related death. The presence of axillary lymph nodes is still an considerable prognostic item in early breast malignancy.
Aim of The Work: To assess the accuracy of the breast elastography in the evaluation of the axillary lymph node in female patients with suspected breast cancer lesions (BIRADS 4, 5).
Patients and Methods: The study included 30 female patients; their ages are between 28 and 65 years. Ultrasound, Strain and Shear wave elastography examinations for their axillary lymph nodes (L.N.s) were done and imaging results of each modality were evaluated individually. This was correlated with pathological diagnosis.
Results: Considering conventional Ultrasound criteria, cortical thickness is the criterion of the highest sensitivity (100% sensitivity) for detecting the malignant LNs. Followed by the vascular pattern. Eratio had the highest indices compared to the rest of elastography criteria (qualitative or Emax.) of sensitivity, specificity, accuracy (76.8%, 100%, 84.5% respectively).
Conclusion: Elastography examinations have no significant value over conventional ultrasound alone.

Keywords: *Axillary lymph node US; elastography; Breast US.*

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INTRODUCTION

One of the independent factors impacting the prognosis of females with breast malignancy is the status of the axillary lymph node. When compared to non-metastatic individuals, the 5-year survival rate of breast cancer females when associated with axillary metastatic L.N. drops by 40%.[1]

Preoperatively, ultrasound is frequently used to identify malignant from benign lymph nodes based on morphological features. Conventional ultrasound has moderate sensitivity for detecting metastatic lymph nodes and false-positive results, leading to overuse of biopsy. Ultrasound is a convenient tool because it provides real-time imaging, high soft tissue resolution, feasibility, and cost-efficiency.

Ultrasound elastography has attracted a lot of interest in recent years thanks to advancements in medical imaging for its non-invasive capacity to detect tissue stiffness in various organs.[3]

The two most extensively utilized elastographic techniques are real-time (strain) elastography (RTE) and shear-wave elastography (SWE). RTE shows a color map superimposed on a two-dimensional image acquired by exerting steady stress to the tissue. It can be used to assess the stiffness of lesions qualitatively (elasticity score) or semi-quantitatively (strain ratio) . [3]

The purpose of this study was to see how useful ultrasound elastography is in determining the status of axillary lymph nodes in individuals with breast malignancy.

PATIENTS AND METHODS

Patients: The study included 30 female patients during the period from August 2021 to January 2022.Their ages ranged from 28 - 65 years (mean age 49.88 ± 7.61 SD).

Inclusion criteria: Female patients with suspected breast cancer lesions (BI-RADS 4 & 5) on mammography and conventional ultrasound.

Exclusion criteria: Female patients with lesions of BI-RADS 1or 2 on mammography and conventional ultrasound.

The cases underwent:

Clinical history taking.

Imaging procedure: Conventional Breast Ultrasound & US elastography.

Equipments: The Conventional Ultrasound and Elastography examinations were performed using

Toshipa aplio 500 ultrasound scanners 9 MHz linear probe.

Technique of Conventional Breast Ultrasound: To examine the axilla the patient lies supine, with the ipsi-lateral hand behind the head and axillary US was performed.

Image analysis and interpretation of Conventional Ultrasound:

Each lymph node was assessed for: shape (oval or non-oval), cortical thickening > 3mm, fatty hilum and vascularity (central or peripheral), and each lymph node was categorized as (benign or malignant) before obtaining the final pathology.

Technique of Ultrasound Elastography: After obtaining traditional US images, Elastographic images were obtained using suitable amounts of jell, and the built-in box was set to include the lesion and surrounding normal tissue, then slight compression to the lymph nodes was applied using the probe (manually in strain elastography or automatically in shear wave elastography). This resulted in a semi-transparent color map of tissue stiffness overlay on the gray-scale image.

Image analysis and interpretation of US Elastography: Each lymph node was assessed using elastography color-coded images and a grading system depending on the ratio of the relatively stiffer regions in the cortex (ratio of yellow/red areas). Elastography grades were applied on a scale of 1 to 4 based on the lymph node elastogram patterns and were blinded to the final pathological diagnosis. The nodes with a grade of 1 or 2 were graded benign, while those with a score of 3 or 4 were considered metastatic (Table 1), as were the cutoff values for strain ratio (in the case of strain elastography) and Emax, Eratio (in the case of shear wave elastography) were calculated & correlated with the pathology results**.**

Score	Assessment
Score 1	Red/Yellow portion occupying almost all of the cortex
Score 2	Blue portion occupying less than 50% of the cortex
Score 3	Blue portion occupying more than 50% of the cortex
Score 4	Blue portion occupying almost all of the cortex

Table 1: Modulated scoring system for elastography color map image.[7]

Results of imaging were correlated with **Histo-pathological results** (obtained by post-operative pathology results or Tru-cut biopsy).

RESULTS

The study was done on 30 female patients with breast cancer at Sayed Galal University Hospital.

		Studied cases (No.= 30)
Histological type	Reactive	**8 (26.7%)**
	Invasive duct carcinoma	**20 (66.6%)**
	Invasive mammary carcinoma	**1 (3.3%)**
	Invasive lobular carcinoma	**1 (3.3%)**
Benign/Malignant	**Benign**	**8 (26.7%)**
	Malignant	**22 (73.3%)**

Table 1: Final diagnosis by pathological examination

		Studied cases (No.= 30)
Age in years	**Mean ± SD Range**	**52.86 ± 6.25** **35 – 75**

Table 2: Distribution of age in the examined patients (n=30).

	True positive (TP)	True negative (TN)	False positive (FP)	False negative (FN)	Sensitivity	Specificity	PPV	NPV	Accuracy
L/S diameter (≤ 2.08)	18	6	1	5	78.26	85.71	94.74	54.55	**0.800**
Cortical thickness (> 7)	15	6	1	8	65.22	85.71	93.75	42.86	**0.700**
Focal thickening	13	3	4	10	56.52	42.86	76.47	23.08	**0.533**
Shape (Rounded)	14	6	1	9	60.87	85.71	93.33	40.0	**0.667**
Absent or compressed Hilum	21	5	3	1	95.45	62.50	87.50	83.33	**0.867**
Total B mood	**23**	**3**	**4**	**0**	**100.0%**	**42.86%**	**85.19%**	**100.0%**	**0.867**

Table 3: Diagnostic criteria of B mode criteria

Ultrasound Elastography:

Qualitative assessment: Elasticity Score

		Benign	Malignant	Test value	P-value	Sig.
		No. = 8	No. = 22			
ES	1	2 (25.0%)	0 (0.0%)	18.558*	0.001	HS
	2	4 (50.0%)	1 (4.5%)			
	3	1 (12.5%)	1 (4.5%)			
	4	1 (12.5%)	14 (63.6%)			
	5	0 (0.0%)	6 (27.3%)			
	Mean ± SD	**2.01 ± 1.23**	**4.12 ± 0.81**	**-4.478•**	**<0.001**	**HS**
	Range	**1 – 4**	**2 – 5**			

Table 4: Distribution of elasticity score in benign and malignant lymph nodes (Chi-squared test)

Variables	Cut off point	AUC	Sensitivity	Specificity	+PV	-PV
ES	>3	0.903	88.89	83.33	94.1	71.4

Table 5: Cutoff value of Elasticity Score (ROC curve analysis)

Quantitative assessment: Strain ratio

		Benign	Malignant	Test value	P-value	Sig.
		No. = 8	No. = 22			
Strain ratio	Median	1.15 (1 – 2.5)	3.5 (2.9 – 5.0)	19.919*	<0.001	HS
	≤ 2.5	8 (100.0%)	2 (9.1%)			
	> 2.5	**0 (0.0%)**	**20 (90.9%)**			

Table 6: Median value, of strain ratio in benign and malignant nodes (T test)

	Cut off point	AUC	Sensitivity	Specificity	+PV	-PV
Strain ratio	>2.5	0.889	88.89	83.33	94.1	71.4

Table 7: Best Strain ratio cutoff value and its diagnostic performance (ROC curve analysis)

DISCUSSION

The assessment of axillary lymph nodes in patients with breast cancer prior to surgery is critical for successful management.[4]

The most extensively utilized procedures for preoperative examination of the axillary L.N. are ultrasound (US) examination and US-guided biopsy. However, the sensitivity is moderate, and false-negative results are possible if the nodes are only assessed with conventional US, leading to over use of sentinel lymph node biopsy, which can result in complications such as upper limb edema. As a result, another noninvasive method is required.[5]

Recent technologies in US, like US elastography, have demonstrated a diagnostic value in a variety of disorders. Based on tissue stiffness, elastography can non invasively differentiate benign and malignant tumors. It has been commonly utilized in breast, liver and thyroid cancer. However, due to a lack of evidence, It is not employed as a regular test in L.N. studying.[6]

The main outcomes of our research were as the following:

The prevalence of malignancy in examined patients was 73.3% and the most common histological type in the examined patients was invasive duct carcinoma 66.7%.

Mariam et al.[7] stated that 18 (75%) of the nodes were found to be metastatic, while the remaining 6 (25%) were found to be benign, which is consistent with our findings. Invasive duct carcinoma was the most prevalent histological type in the patients studied (66.6%).

The present study showed that the age is between 28 and 65 years. There was no significant difference in age between patients who had benign lymph nodes and those who had malignant lymph nodes (P-value > 0.05).

Our results were supported by study of Chang et al.[8] as they reported that the mean age of the patients was 55.3 ± 13.0 years (range, 21–85 years).

In the study we conducted, we discovered that L/S diameter had overall sensitivity and specificity of 78.26 percent and 85.71 percent, respectively, in evaluating lymph nodes in breast cancer females. Cortical thickness had a sensitivity and specificity of 67.0 percent and 83.3 percent, respectively. Total B mode had the highest sensitivity (100%), followed by Absent or compressed Hilum, which had a sensitivity of 95.45%. L/S diameter (≤2.08), Cortical thickness (>7) and shape had the highest specificity, with 85.71 percent in each. Total B mood showed a sensitivity and specificity of 100 percent and 42.86 percent, respectively.

This criterion sensitivity fits with Abe et al. (10). Their research included 50 patients who submitted to conventional and strain elastography US. They discovered that the most sensitive ultrasound feature predictive of malignancy was a lost or compressed nodal hilum, which was found in 93.3 % of the examined L.N.s.

The present study showed that as regard Ultrasound Elastography; Qualitative assessment: Elasticity Score, the mean value of malignant L.N.s was substantially greater than benign nodes (P value <0.001). Using receiver operating characteristic (ROC) curve; elasticity Score exhibited overall sensitivity and specificity of 88.89% and 83.3% respectively.

According to Choi et al.[9], score 1 denotes no or scanty blue regions, score 2 denotes small blue regions, totally less than 45 percent, score 3 denotes large blue regions, totally more than 45 percent, and score 4 denotes blue regions occupying the whole cortex. Score >2 was the best cutoff value for malignancy, yielding 88.9% sensitivity, 73.3 percent specificity, 86.7 percent accuracy, 88.9 percent PPV, and 83.3 percent NPV.

In terms of quantitative assessment: strain ratio, the current study found that the mean value of strain ratio is substantially higher in metastatic nodes than benign ones (P value 0.001). Strain ratio had an overall sensitivity and specificity of 88.89 percent and 83.3 percent, respectively.

Our findings were corroborated by Mariam et al.[7], who found a significant increase in mean strain ratio in malignant nodes (1-8.3) compared to benign nodes.

In agreement with our study, Zhang et al[(11)] found that the strain ratio of the malignant lymph nodes was more than that of the benign ones with the best strain ratio cutoff point was 2.395, with the sensitivity and specificity of 78.41% and 98.51%, AUC was 0.915.

CONCLUSION

In the examination of the axillary lymph nodes in patients with breast cancer, the addition of strain or shear wave elastogrphy offers no substantial value over conventional ultrasound alone.

Conflict of interest : none

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