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DECODING THE APPLICATION OF GRAYSCALE ULTRASOUND, COLOUR DOPPLER AND ULTRASOUND ELASTOGRAPHY IN EVALUATION OF AXILIARY LYMPH NODE IN SUBJECTS DIAGNOSED WITH PRIMARY BREAST CANCER

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ABSTRACT

Introduction: The axillary lymph nodes are the most prevalent location of breast cancer metastases. One of the most important and dependable prognostic variables for individuals with breast cancer is the presence of axillary lymph nodes. It's critical to distinguish benign axillary lymph nodes from malignant ones as soon as possible in order to enhance survival and outcomes and avoid treatable lesions from becoming incurable.

Aims: In this study, axillary lymph nodes in women with breast cancer were evaluated by strain wave elastography, colour doppler, and greyscale ultrasonography, and their histologic correlation was examined. The current study also examined the specificity, sensitivity, negative and positive predictive values, and combination of elastography and greyscale ultrasound results with greyscale ultrasound results.

Methods: Following a histopathology-based diagnosis of carcinoma in the breast, 68 individuals had their axillary lymph nodes evaluated for vascularity, shape, size, hilum presence or absence, cortical thickness, fatty hilum thickness ratio (C/F ratio), long/short axis ratio (L/S ratio), and elastography.

Results: The diagnosis was established, and histology supported it. Increased C/F ratio, decreased L/S ratio, increased cortical thickness, eccentric/compressed or missing hilum, irregular nodular borders, and round shape in morphology were observed to be favourable factors for malignancy. Based on the resistivity index, vascular flow pattern type, and peak systolic/end-diastolic velocity/ratio, benign and malignant lymph nodes were distinguished. The mean strain ratio was greater in malignant lymph nodes than in benign lymph nodes.

Conclusions: Because ultrasound is accurate, easily accessible, radiation-free, and reasonably priced, it should be routinely included in the initial screening of subjects with breast carcinoma. This includes strain elastography, colour Doppler, and greyscale ultrasound.

Key Words: Axillary lymph nodes, Colour Doppler, Elastography, Grayscale ultrasound

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INTRODUCTION

Breast cancer (BC) is the commonest malignancy among women globally.[1] In India, the incidence has increased significantly, almost by 50%, between 1965 and 1985.[2] The estimated number of incident cases in India in 2016 was 118000 (95% uncertainty interval, 107000 to 130000), 98.1% of which were females, and the prevalent cases were 526000 (474000 to 574000). Over the last 26 years, the age-standardised incidence rate of BC in females increased by 39.1% (95% uncertainty interval, 5.1 to 85.5) from 1990 to 2016, with the increase observed in every state of the country.[3]

Before distant metastases, breast cancer often spreads via intraductal growth and local invasion to the lymphatics in a predictable and step-by-step manner.[4] The axillary lymph nodes are the most often affected location of breast cancer metastases. One of the most important and dependable prognostic variables for individuals with breast cancer is the presence of axillary lymph nodes. It's critical to distinguish benign axillary lymph nodes from malignant ones as soon as possible in order to enhance survival and outcomes and avoid treatable lesions from becoming incurable. It is essential to distinguish between benign and malignant axillary lymph nodes in order to improve survival and results.[5]

Sentinel lymph node (SLN) receives the early lymphatic outflow from cancer breast and aids in the precise estimation of the lymph node status of the remaining axillary lymph nodes.[3] Due to its high cost, the requirement for nuclear medicine, the false-negative rate, arm weakness, restricted shoulder motions, discomfort, lymphedema, post-procedure problems, waiting times, and frozen section facilities, sentinel lymph node biopsies are not widely accepted in poor nations. Therefore, it is essential to use and employ non-invasive techniques like strain wave elastography, colour Doppler, and ultrasonography in order to distinguish benign lymph nodes from malignant lymph nodes. These techniques are effective and beneficial in this regard.[6] Malignant axillary lymph nodes and breast cancer can be diagnosed and treated to increase survival rates, enhance quality of life, and reduce related mortality.

In this study, axillary lymph nodes in women with breast cancer were evaluated by strain wave elastography, colour doppler, and greyscale ultrasonography, and their histologic correlation were examined. The current study also examined the combination of elastography and greyscale ultrasound results with greyscale ultrasound results.

MATERIAL AND METHODS

In order to evaluate axillary lymph nodes in people with breast cancer using strain wave elastography, colour doppler, and greyscale ultrasonography and to correlate them histopathologically, the current prospective observational clinical investigation was carried out. The current study also examined the specificity, sensitivity, negative and positive predictive values, and combination of elastography and greyscale ultrasound results with greyscale ultrasound results.

The study was conducted at MCSRC, Patna from 1/08/2023 to 31/10/2023 . After obtaining clearance from the concerned Ethical committee. After explaining the detailed study design, informed consent was taken from all the subjects in both written and verbal form. There were 68 participants in all, ages 35 to 78, with a mean age of 52.4±4,62 years, in the research.

Female participants in the trial had a verified histopathologic diagnosis of breast cancer based on radiographic imaging demonstrating the axis of axillary lymph nodes less than 5 mm. The

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study excluded participants with a history of past axillary procedures, neoadjuvant chemotherapy, radiation, and bilateral breast surgery related to bilateral cancer breast.

Using a multi-frequency linear array transducer, strain wave electrocardiography, colour doppler, and greyscale ultrasonography were performed in the axillary lymph nodes of all afflicted participants. When primary breast cancer patients were in the supine position with their shoulders abducted 90 degrees, an ultrasonography of the ipsilateral axilla was performed.

This was done for positioning the axillary levels following a straight course so that all axillary parts can be thoroughly assessed. Compression of the variable amount was applied with a transducer for thinning of axillary area, which further helps in improving the image quality and wave penetration.

The morphology of the lymph nodes was also evaluated, and in those whose axillary lymph nodes seemed normally, the most representative lymph node in the lower axilla was chosen for additional examination. All of the participants underwent normal techniques for strain wave elastography, colour doppler ultrasonography, and greyscale ultrasound. Greyscale ultrasonography revealed the following characteristics: localised thickening of the cortex, sharp edges, presence or absence of fatty hilum, cortical/fatty hilum thickness ratio (C/F), long axis/short axis ratio (L/S), and oval or round appearance. Pulsatility index (PI), systolic/diastolic (S/D) ratio, and resistivity index (RI), where the maximum value was obtained, were evaluated using colour doppler ultrasonography. After vascularity distribution of lymph nodes, four types of nodes were identified: hilar, central perihilar, peripheral non-hilar and mixed.

The assessed findings were correlated with the obtained histopathologic data in order to find results. For additional research, the number and dimensions of the largest lymph nodes were linked histopathologically. Thus, 74 lymph nodes from 74 research subjects were assessed. Both of the combined greyscale ultrasonography and elastography findings are compared to the greyscale ultrasound results. Using SPSS software version 21 (Chicago, IL, USA) for statistical assessment and one-way ANOVA and t-test for result formulation, the gathered data were examined. The data were presented as a mean, standard deviation, percentage, and number. At $p<0.05$, the significance threshold was maintained.

RESULTS

In order to evaluate axillary lymph nodes in people with breast cancer using strain wave elastography, colour doppler, and greyscale ultrasonography and to correlate them histopathologically, the current prospective observational clinical study was carried out.

There were 74 participants in all, ages 32 to 79 yrs in the research. Out of the 74 lymph nodes that were evaluated, 50 had metastases, and 24 had benign nodes. Table 1 provides an overview of the features of axillary lymph nodes in study subjects. The findings revealed that whereas compressed/eccentric localization was observed in 8.3% (n=4) and 91.7 % (n= 50) of people with benign and malignant lymph nodes. Subjects with benign lymph nodes showed central maintained hilum in 95.2% (n = 20) and malignant lymph nodes in 4.8% (n = 1) of cases, respectively. 85.2% (n=23) and 14.8 % (n=4) of the individuals with benign and malignant nodes, respectively, had the oval form. 97.7 % (n=50) of the individuals had irregular nodular borders in malignant nodes.

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In benign nodes, the vascular pattern was mostly hilar, as shown as 78.3% (n=18) in research individuals; in malignant nodes, on the other hand, the mixed flow pattern was prevalent and observed in 93.8% (n=30) study patients.

For both benign and malignant nodes, the S/D ratio was 3.09±0.41and 6.5±4.7, respectively; for RI, it was 0.64±0.06 and 0.80±0.12, and for PI, it was 1.16±0.24 and 1.5±0.35. The ratios for cortical/fatty hilum thickness (C/F) were 0.76±0.35 and 4.43±3.37, cortical thickness was 2.13±0.72 and 7.6±3.06, and for long axis/short axis ratio (L/S), the corresponding values were 12.08±2.57and 1.44±6.40.

Table 1, 2 and 3 indicates that all these characteristics were significantly higher in malignant axillary lymph nodes than in benign axillary lymph nodes.

The results of the combined examination colour doppler, ultrasound elastography, and greyscale ultrasonography were evaluated and linked with the histopathologic findings. The findings demonstrated that malignant tumours in coherence to histology were 98% (n=49), whereas 1 case (2.0%) was negative. Colour Doppler revealed that for malignant cases, 96% (n=48) had histopathologic correlation and 4.0% (n=2) had false positives; for benign cases, 12.5% (n=3) had false positives and 87.5% (n=21) had correlated histopathologic results.

Comparable findings were seen with elastography: in malignant nodes, 96% (n=48) of patients demonstrated correlation on histopathologic evaluation, whereas in benign nodes 87.5% (n=21) of instances, histopathologic correlation was observed. Table 3 illustrates that this difference was statistically significant with $p<0.0001$.

DISCUSSION

In order to evaluate axillary lymph nodes in people with breast cancer using strain wave elastography, colour doppler, and greyscale ultrasonography and to correlate them histopathologically, the current prospective observational clinical study was carried out.

There were 74 participants in all, ages 35 to 78 years, in the research. Out of the 74 lymph nodes that were evaluated, 50 had metastases, and 24 had benign nodes.

The findings from Table 1 provide an overview of the features of axillary lymph nodes in study subjects. The findings revealed that compressed/eccentric localization was observed in 8.3% (n=4) and 91.7 % (n= 50) of people with benign and malignant lymph nodes. Subjects with benign lymph nodes showed central maintained hilum in 95.2% (n = 20) and malignant lymph nodes in 4.8% (n = 1) of cases, respectively. 85.2% (n=23) and 14.8 % (n=4) of the individuals with benign and malignant nodes, respectively, had the oval form. 97.7 % (n=50) of the individuals had irregular nodular borders in malignant nodes.

In benign nodes, the vascular pattern was mostly hilar, as shown as 78.3% (n=18) in research individuals; in malignant nodes, on the other hand, the mixed flow pattern was prevalent and observed in 93.8% (n=30) study patients.

These findings aligned with the findings of Latif MA et al (2016)[7] and Chang W et al (2018)[8], whose authors observed comparable illness features. According to the study's assessment of the vascular pattern, 82.60% (n=38) of the study subjects had a mixed pattern in their malignant axillary lymph nodes, while 45.45% (n=10) of the study subjects had a hilar pattern, followed by non-hilar in 31.81% (n=7) of the subjects.

For both benign and malignant nodes, the S/D ratio was 3.09±0.41and 6.5±4.7, respectively; for RI, it was 0.64±0.06 and 0.80±0.12, and for PI, it was 1.16±0.24 and 1.5±0.35. The ratios

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for cortical/fatty hilum thickness (C/F) were 0.76±0.35 and 4.43±3.37, cortical thickness was 2.13±0.72 and 7.6±3.06, and for long axis/short axis ratio (L/S), the corresponding values were 12.08±2.57and 1.44±6.40.

When comparing malignant axillary lymph nodes to benign one, all these metrics showed a substantial increase ($p<0.0001$). These findings corroborated those of research by Liu H et al[9] in 2018 and Park Y et al (2014),[10] the authors of which reported ultrasonography parameters compared to the current investigation.

The results of the combined examination colour doppler, ultrasound elastography, and greyscale ultrasonography were evaluated and linked with the histopathologic findings. The findings demonstrated that malignant tumours in coherence to histology were 98% (n=49), whereas 1 case (2.0%) was negative. Colour Doppler revealed that for malignant cases, 96% (n=48) had histopathologic correlation and 4.0% (n=2) had false positives; for benign cases, 12.5% (n=3) had false positives and 87.5% (n=21) had correlated histopathologic results.

Comparable findings were seen with elastography: in malignant nodes, 96% (n=48) of patients demonstrated correlation on histopathologic evaluation, whereas in benign nodes 87.5% (n=21) of instances, histopathologic correlation was observed. Table 3 illustrates that this difference was statistically significant with $p<0.0001$. These findings were in line with those of Maxwell F et al. (2015)[11] and Choudhary J. (2017)[12] whose authors also saw comparable findings in axillary lymph nodes linked to breast cancer on greyscale, colour doppler, and elastography.

CONCLUSION

With all due to its limitations, this study comes to the conclusion that ultrasonography, which includes strain elastography, colour Doppler, and greyscale ultrasonography, ought to be a regular part of the initial screening process for patients diagnosed with breast cancer because of its many benefits, including cost-effectiveness, accuracy, ease of use, and lack of radiation. A few drawbacks of the current study were, nonetheless, a limited sample size, a brief monitoring period, and biases related to geographic areas. Therefore, further long-term research with bigger sample sizes and longer observation periods will aid in coming to a conclusive result.

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TABLES

Features	Subgroup	Benign % (n=24)	Malignant % (n=50)	p-value
Hilum Localization	Absent	0	100 (5)	0.000
	Compressed/Eccentric	8.3 (4)	91.7 (44)	
	Central and maintained	95.2 (20)	4.8 (1)	
Shape type	Irregular nodular margins	2.5 (1)	97.5 (39)	0.000
	Round	0	100 (7)	
	Ovoid	85.2 (23)	14.8 (4)	

Table 1: Association 0f morphological characteristics of lymph nodes with histopathological diagnosis of lymph nodes

Vascularity	Subgroup	Benign % (n=24)	Malignant % (n=50)	p-value
	Mixed flow pattern	6.2 (2)	30 (93.8)	0.000
	Peripheral non-hilar flow pattern	0	100 (5)	
	Central perihilar flow pattern	28.6 (4)	71.4(10)	

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	Hilar flow pattern	78.3 (18)	21.7(5)	

Table 2: Association between vascular patterns of axillary lymph node with HPE lymph node diagnosis

	HPE diagnosis of axillary lymph nodes		
	Benign % (n=22)	**Malignant % (n=46)**	
Variables	**Mean± S.D**	**Mean± S.D**	**p**
Systolic/diastolic ratio	3.09±0.41	6.5±4.7	<0.001
Resistivity index (RI)	0.64±0.06	0.80±0.12	0.000
Pulsatility index (PI)	1.16±0.24	1.5±0.35	0.000
Cortical/fatty hilum thickness ratio(C/F),	0.76±0.35	4.43±3.37	0.000
Cortical thickness	2.13±0.72	7.6±3.06	0.000
Long axis/short axis ratio (L/S)	12.08±2.57	1.44±6.40	0.000

Table 3: Comparison of ultrasound parameters with histopathologic findings of axillary lymph nodes in the study subjects

Features	**Subgroup**	**Benign % (n=22)**	**Malignant % (n=46)**	**Total**
Combined	Malignant	12.5 (3)	98.0 (49)	<0.001
	Benign	87.5 (21)	2.0 (1)	0.000
Elastography	Malignant	8.3 (2)	96.0 (48)	0.000
	Benign	91.6 (22)	4.0 (2)	0.000
Color Doppler	Malignant	12.5 (3)	96.0 (48)	0.000
	Benign	87.5 (21)	4.0 (2)	0.000
Greyscale	Malignant	16.6 (4)	94.0 (47)	<0.0001
	Benign	83.3 (20)	6.0 (3)	

Table 4: Association of histopathologic findings to greyscale, elastography, color doppler and combined results in the study subjects

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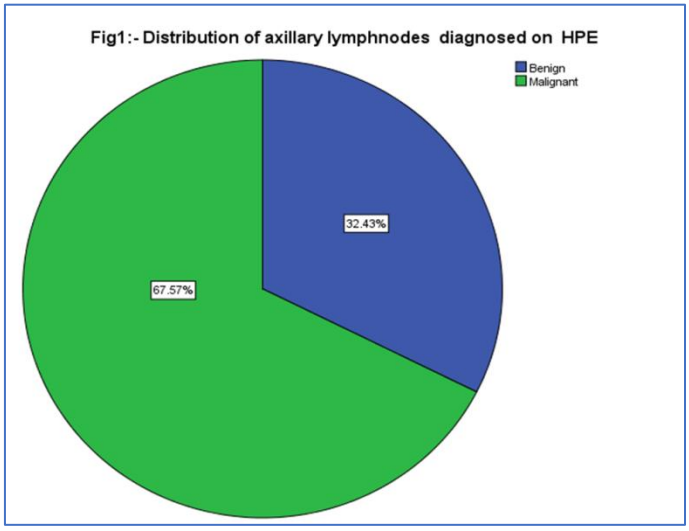

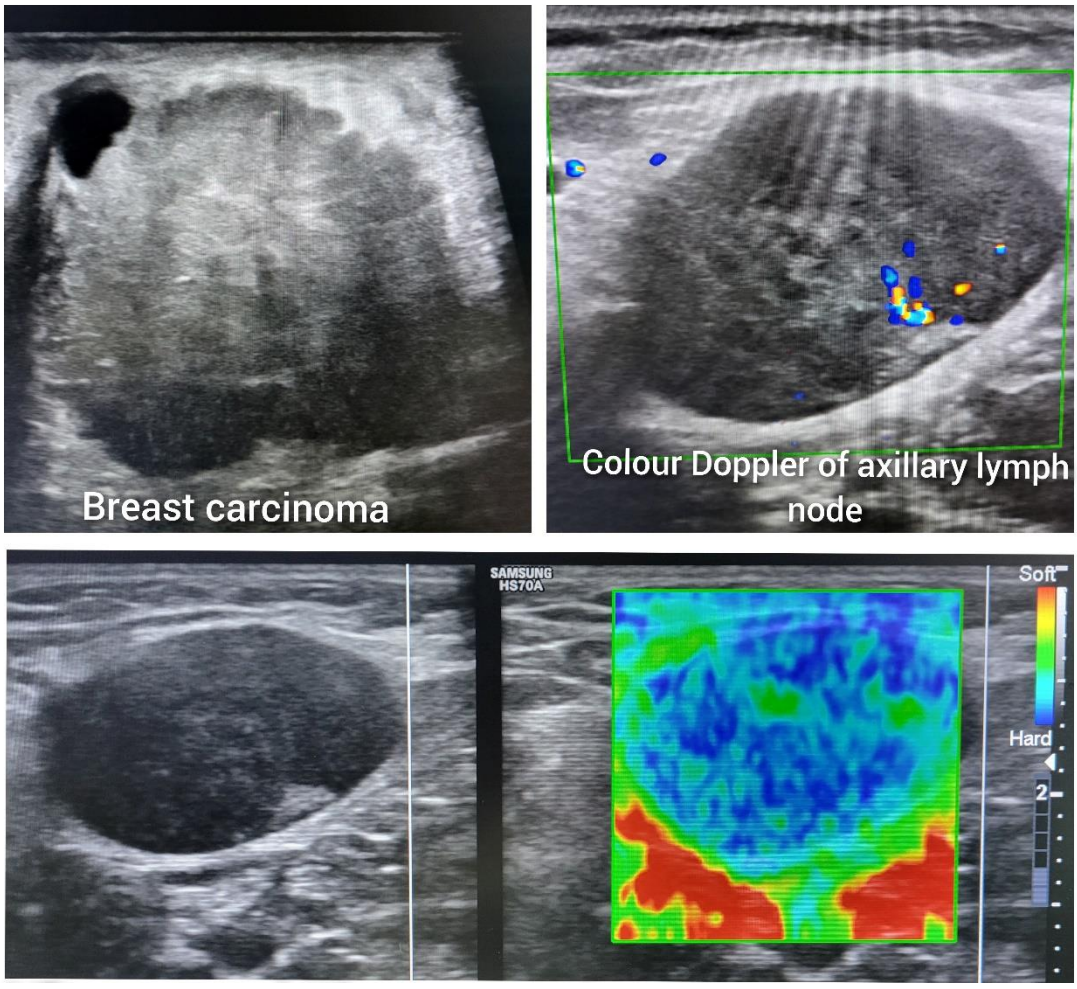

Fig.2: - Colour Doppler and elastography of a metastatic axillary lymph node in a case of breast carcinoma

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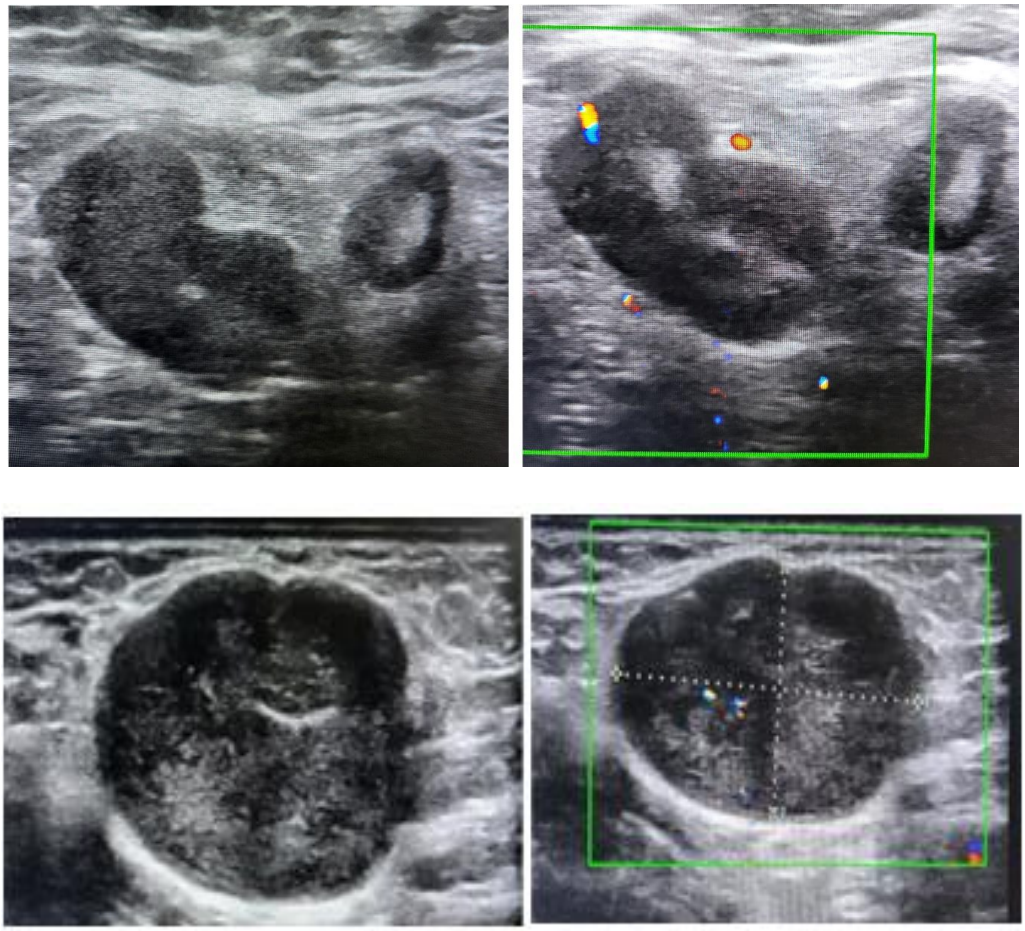

Fig.3:-Grey scale ultrasound and Colour Doppler of metastatic axillary lymph nodes in cases of breast carcinoma