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Original Research Article

Ultrasound Elastography in Evaluation of Cervical Lymphadenopathy with FNAC Correlation

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Conflict of interest: Nil

Abstract

Introduction: When ultrasonography and elastography are used together, it is more accurate to distinguish benign from malignant cervical lymph nodes. This helps with treatment planning and reduces the need for fine needle aspiration cytology and biopsy. The purpose of this study was to evaluate the sensitivity, specificity, and diagnostic accuracy of B-mode ultrasonography, colour Doppler imaging, and elastography, as well as to correlate these results with pathological findings.

Aims and objectives: 1. To determine the role and diagnostic value of ultrasound elastography in differentiating benign from malignant cervical lymph nodes.

2. To evaluate the accuracy and efficacy of ultrasound elastography in discriminating benign from malignant cervical lymph nodes by comparing the results of the two techniques with pathological (FNAC) confirmation.

Materials and Methods: B-mode and colour Doppler ultrasonography were used to examine patients first, followed by elastography. Short axis diameter, short-to-long axis ratio, fatty hilum, and margin were all examined on B-mode USG imaging. Color Doppler imaging was used to identify five patterns of lymph node vascularity. Lymph nodes were examined using elastography based on the strain ratio and elastography pattern.

Results: The fatty hilum and vascularity patterns were observed to have the highest diagnostic accuracy of 84%, followed by the short-to-long axis ratio (82%). B-Mode USG's overall sensitivity, specificity, and diagnostic accuracy were 88.1%, 66.6%, and 85.0% respectively. The current study found that using a strain ratio cut-off of 1.5 resulted in 87.2% sensitivity, 93.3% specificity, and 90% diagnostic accuracy. Ultrasonography and elastography were performed together to achieve a sensitivity of 96.3%, specificity of 80.8%, and diagnostic accuracy of 81.0%.

Conclusions: To correctly diagnose cervical lymphadenopathy, elastography can be a helpful adjunct to ultrasonography. The cut-off strain index of 1.5 and the elastography pattern can successfully distinguish between benign and malignant.

Keywords: Grey scale Ultrasound, Elastography, FNAC.

Introduction

Several pathologic events, including infections, vasculitis, and cancers like lymphoma and metastases, can result in cervical lymphadenopathy, a condition that physicians frequently encounter in clinical practice [1].

Various imaging modalities are used to evaluate the possible etiology of cervical lymph node enlargement like computed tomography (CT), Magnetic resonance imaging (MRI) & ultrasound (US) [2]. Among them, Ultrasonography (USG) is generally the first desired imaging modality since it can be used to evaluate the condition and provide information about the underlying cause as well as aid in treatment planning. For the assessment of lymph nodes, various criteria are proposed for B-mode ultrasound and color Doppler imaging (CDI). However, there is a significant overlap in the diagnostic criteria for identifying benign and malignant cervical lymph nodes using B-mode ultrasonography and CDI [3].

Based on the stiffness of the tissues, elastography can assist characterize lymph nodes (malignant tissues are harder than benign). The relative stiffness of the lymph node in relation to nearby normal tissue in response to an externally applied manual force is measured by strain elastography [4].

Color-coding of the cervical lymph nodes (CLN) and surrounding normal muscle indicates different levels of tissue hardness. The percentage of the blue or hard area on elastograms is used to explain the pattern of elastography [5].

The muscle-to-lymph node strain ratio, also known as the strain index (SI), is a semi-quantitative measurement based on the elasticity of the target lymph node to the surrounding neck muscles. As the strain index rises, the likelihood of malignancy increases.

Elastography can help ultrasonography diagnose cervical lymphadenopathy more precisely. Additionally, it might help in deciding on CLN for fine-needle cytology (FNAC), which is necessary for precise diagnosis and treatment [4,6].

The purpose of this study was to find out if Sono elastography can accurately distinguish between benign and malignant cervical lymph nodes. Additionally, this study attempted to determine the sensitivity, specificity, and diagnostic accuracy of elastography and B-mode ultrasonography as well as to correlate the outcomes of these procedures with histopathological findings.

Materials & Methods

Source of data

On 100 individuals with enlarged cervical lymph nodes, the study was conducted from 1st June 2021 to 31st May 2022 for a period of 1 year in the Department of Radiodiagnosis, Silchar Medical College and Hospital, Silchar. Before including the patients in the study, informed consent was obtained from them by institutional ethics committee approval. The study included all patients with enlarged CLN who are referred for USG. Patients who recently underwent a lymph node FNAC or biopsy as well as radiation, chemotherapy or both were excluded.

Method of collection of data:

After informed consent from the patient, a dedicated cervical lymph node ultrasound was performed using a SAMSUNG RS80A ultrasound machine with an L3-L2A linear array transducer that was equipped with elastoscan.

Lymph node morphology was defined on USG and vascularity on CDI. B-mode parameters that were evaluated include short-axis dimension (cut-off value: 8mm), short-to-long axis ratio (cut-off value: 0.6), fatty hilum (presence or absence of hilum), and lymph node margin (regular or irregular). Based on the vascularity on CDI, lymph nodes are divided into five patterns- Pattern 1 (hilar vascularity or no flow), Pattern 2 (peripheral vascularity), Pattern 3 (mixed vascularity), Pattern 4 (absent vascularity), and displaced hilar pattern of vascularity. Patterns 1, 4, and 5 are considered benign patterns, and patterns 2 and 3 are considered malignant patterns. Lymph nodes on elastography were evaluated based on two criteria – elastography pattern and strain ratio. Strain elastography was carried out using a free-hand compression technique and quality assurance. Until a steady image was established, compression and decompression were continued without allowing the hand to move laterally. The elastogram's color coding in our machine was set from red to blue. Blue was chosen for more rigid tissue that deforms less under compression, and red was chosen for softer tissues that deform more under compression. Green was regarded as being in the middle.

Table 1: Pattern on elastogram for lymph node characterization [11].

Pattern 1	Absent or very hard blue areas
Pattern 2	Small scattered hard or blue areas (<45%)
Pattern 3	Large hard or blue areas (>45%)
Pattern 4	The peripheral blue area and central green area, suggest central necrosis
Pattern 5	Blue area occupying entire lymph node with or without a green or soft rim

Patterns 1 and 2 were considered benign in our study. Patterns 3, 4, and 5 were considered malignant.

Following that, the strain ratio was calculated which was taken as the ratio of the hardness of the lymph node compared with the adjacent normal tissue or muscles. The first region of interest (ROI 1) was placed in the lymph node and the second region of interest (ROI 2) was placed in the adjacent muscle at the same level. The strain ratio was calculated as the ratio of ROI 1 to ROI 2 and values were generated. The cut-off strain ratio used was taken as 1.5 in our study. As the stiffness of the lesion increases the strain ratio and the likelihood of malignancy increase.

Both USG and elastography findings were recorded and interpreted. The patient underwent pathological investigation, either ultrasound guided FNAC or biopsy. Elastography and USG findings were compared with pathological findings.

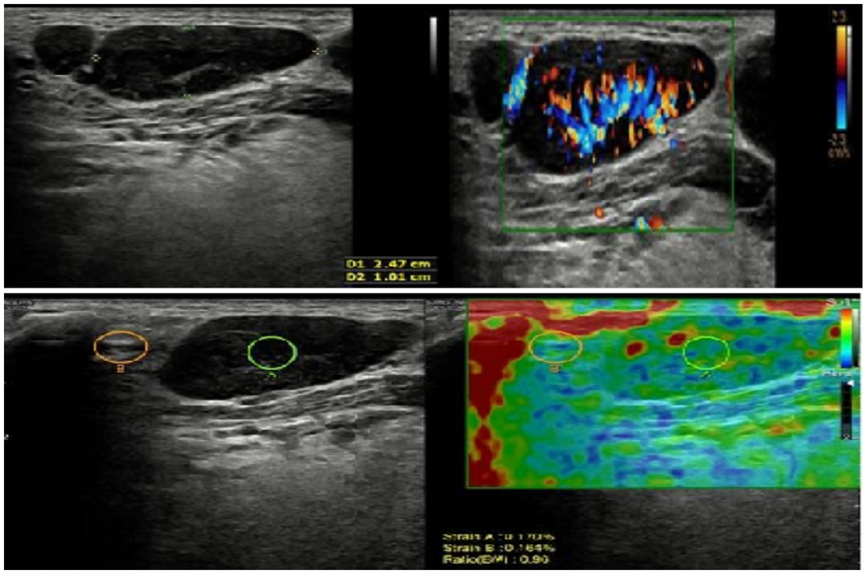

Figure 1: On grey scale USG, the lymph node is oval in shape with preserved fatty hilum showing a hilar pattern of vascularity on Color Doppler study. On elastography, the lymph node has elastography pattern 2 and SR of 0.96.

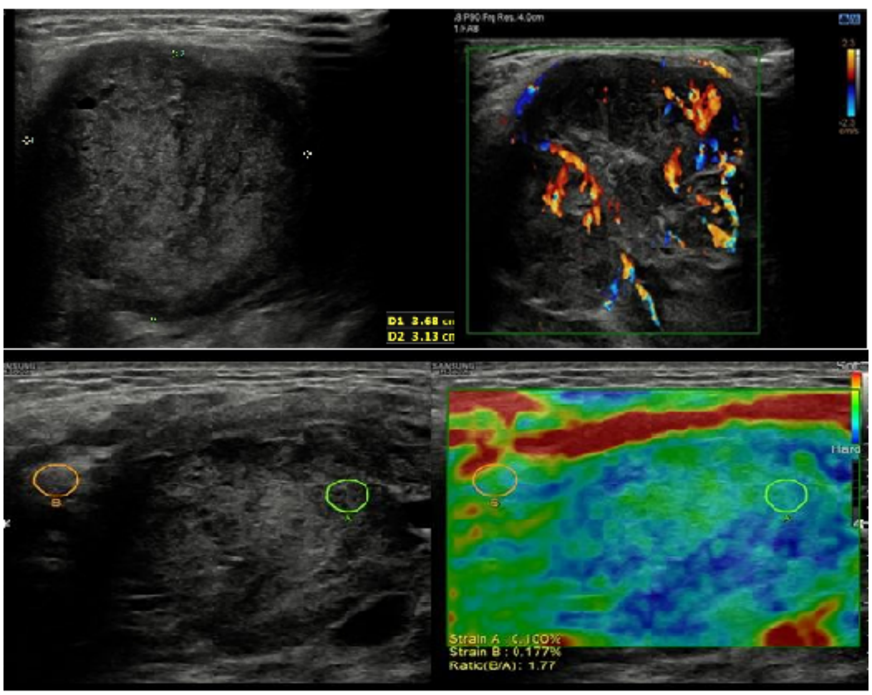

Figure 2: On grey scale USG, the lymph node is round in shape with few areas of internal necrosis showing a mixed pattern of vascularity on the Colour Doppler study. On elastography, the lymph node shows pattern 3 with an SR of 1.7.

Results

The age of the patients ranged from 7 to 78 years (mean: 40.9 ± 16.9 years). About 55% (*n* = 55) were female and 45% (*n* = 45) were male. Of the 100 LNs examined, 45 (45%) were benign and 55 (55%) were malignant on histopathology. Of the 45 benign LNs, 20 had been reported as reactive and 25 as tuberculous lymphadenitis. Among the 55 malignant nodes, 35 were metastatic and 20 were due to lymphoma.

In our study, there were no significant differences between the benign and malignant LNs concerning lymph node borders, intranodal necrosis, and echogenicity (*P* = 0.47, P=0.143, and *P* = 0.283, respectively). Hilum was found to be abnormal in 47 lymph nodes out of 55 malignant nodes studied. 87.2% of malignant LNs (*n* = 48) had S/L ratio less than 0.6 and 75.5% (*n* = 34) of benign LNs had S/L ratio more than 0.6 (*P* = 0.001). Among all B-mode parameters, the hilum of LN had the highest diagnostic accuracy (84%), while the nodal border was found to have the least accuracy (45%). On color Doppler evaluation, nearly 88% (*n* = 40) of benign nodes showed a benign flow pattern compared to 80.0% (*n* = 44) of malignant nodes (*P* = 0.001).

Table 2: Shows the correlation of short to long axis ratio (S/L) and pathological diagnosis of LNs.

	FNAC			
s/L RATIO	**Malignant**	**Benign**	**Total**	**P value**
>0.6=Malignant Nodes.	48	11	59	<0.001
<0.6=Benign Nodes.	7	34	41	
Total	55	45	100	

Table 3: Shows the correlation between Fatty hilum of lymph nodes and pathological diagnosis of LNs.

	FNAC		
HILUM	**Malignant**	**Benign**	**Total**
Absent	47	8	55
Present	8	37	45
Total	55	45	100

Table 4: Shows the correlation between nodal margin and pathological diagnosis of LNs.

MARGIN	Malignant (HPE)	Benign (HPE)	Total	P value
Regular	17	17	34	0.471
Irregular	38	28	66	
Total	55	45	100	

Table 5: Shows the correlation between the color Doppler pattern and the pathological diagnosis of LNs.

DOPPLER FLOW	Malignant (FNAC)	Benign (FNAC)	Total	P value
Malignant (2+3)	44	5	49	
Benign (1+4+5)	11	40	51	<0.001
Total	55	45	100	

Table 6: Ultrasound characteristics and their diagnostic performances

Ultrasound Criteria	Sensitivity (Percentage)	Specificity (Percentage)	PPV (Percentage)	NPV (Percentage)	Accuracy (Percentage)
Short to long axis ratio (S/L)	87.2	75.5	81.3	82.9	
Hilum	85.4	82.2	85.4	82.2	84.0
Nodal borders	30.9	62.2	50	42.4	45.0
Colour Doppler	80.4	88.9	89.8	78.4	84.0

Table 7: Shows the Correlation between Strain Ratio and pathological diagnosis of LNs.

	HPE			
STRAIN RATIO(SR)	**Malignant**	**Benign**	**Total**	**P value**
>1.5 Malignant Nodes	48	3	53	
<1.5 Benign Nodes.	7	42	47	
Total	55	45	100	<0.001

Table 8: Shows the diagnostic performance of the Strain Ratio

Statistical analysis of Strain Ratio	Value	95%Cl
Sensitivity	87.27%	75.52% to 94.73%
Specificity	93.33%	81.73% to 98.60%
PPV	94.12%	84.22% to 97.96%
NPV	85.71%	7494% to 92.33%
Accuracy	90.00%	82.38% to 95.10%

The majority of Malignant LNs (*n*=53) had an elastography strain ratio >1.5 while the majority of benign LNs (*n* = 47) had a strain ratio <1.5. A higher strain ratio was significantly associated with malignant histopathology (*P* = 0.001) which was statistically significant.

Table 9: Diagnostic performance of Elastography, B mode USG and Combined evaluation (B-mode and Elastography) Pathological Diagnosis of Cervical Lymph Nodes

Parameters	Sensitivity (percentage)	Specificity (percentage)	Accuracy (percentage)
Overall diagnostic performance of B-mode USG	88.1	66.6	85
Overall diagnostic performance of Elastography	90.9	93.3	92
B-mode USG + Elastography	96.3	67.8	81

Following USG and elastography, the patient underwent FNAC or biopsy of the lymph node. On final diagnosis, 45 out of 100 (45%) patients had benign lymph nodes and 55 (55%) patients had malignant lymph nodes. Among benign CLN, tuberculous lymphadenitis (25%) was found to be most common followed by reactive lymphadenitis (20%). Among malignant CLN, metastatic lymph nodes accounted for 35% and lymphoma cases accounted for 20%.

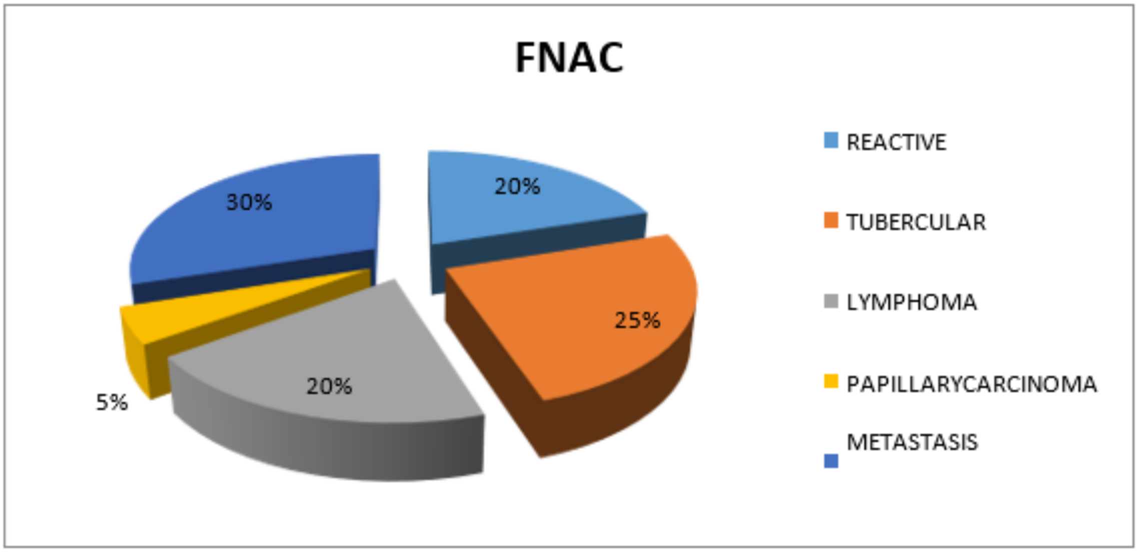

Chart 1: Showing percentage of benign and malignant nodes on pathological confirmation (FNAC).

Discussion

In this prospective study from India, we evaluated the performance of RTE (real-time elastography) in the differentiation of benign and malignant cervical LNs. Our results indicate that RTE has a high specificity and diagnostic accuracy for the identification of malignant LNs.

Due to its noninvasiveness and accessibility, B-mode US is the most widely used method for categorizing cervical LNs; however, the exact criteria for differentiating between benign and malignant LNs are still unknown. In most instances, the combination of indicators results in a highly suggestive appearance. The accuracy rate in our study for identifying benign and malignant LNs was highest for LN fatty hilum (84.0%), and the lowest for nodal borders (45.0%).

Our short-to-long axis ratio criterion showed 87.2% sensitivity, 75.5% specificity, and 82.0% diagnostic accuracy. This correlated with the study of Vineela *et al* (2022) [7], where they reported a sensitivity of 87%, specificity of 32%, and accuracy of 67%. Another study conducted by Hefeda *et al* (2014) [2], reported an accuracy of 69.2%, a sensitivity of 79.2%, and a specificity of 51.1%.

The absence of visible hilum due to replacement or effacement is considered an important criterion for malignant LNs and has been reported by several authors. Our study gave the sensitivity and specificity 85.4% and 82.2% respectively. A study conducted by Hefeda *et al* (2014) [2], found sensitivity and specificity of 84.1 and 82.2 respectively. Moharram *et al* (2017) [8], also revealed a sensitivity and specificity of 96 and 82 respectively.

Cortical hypertrophy was thought to be a sign of malignancy when it appeared eccentrically. Only 9% of the malignant nodes in our investigation had eccentric cortical enlargement. Eccentric cortical hypertrophy was only observed in malignant nodes, according to a study conducted by Ahuja and Ying *et al*. (2002) [9], which denotes localized infiltration. Intranodal calcifications in five (5) of our study subjects turned out to be thyroid papillary carcinoma metastases. Although it is not a malignancy indicator, it can aid in the diagnosis of some malignancies, such as papillary and medullary carcinoma metastases. In a study by Ahuja *et al* (2008) [10], they found that intranodal calcifications were more frequent in cases with thyroid metastases from papillary carcinoma than from medullary cancer. Between benign and malignant LNs, we observed a statistically significant change in vascular patterns (P = 0.001). Our findings are comparable to those made by Zhang *et al* (2009) [11], and Moharram *et al* (2017) [8], who found notable variations in vascularity between benign and malignant LNs. In our study, vascularity of LN had an 84.0% accuracy rate for predicting malignancy. Despite the possibility that combined B-mode US and Doppler could be helpful in differentiating benign from malignant LNs, this modality could not have a clear diagnostic value due to some overlapping sonographic features of benign and malignant nodes. As a result, pathological confirmation is necessary for conclusive diagnostic outcomes. Since RTE is noninvasive, it has been proposed as an additional imaging method to conventional US, which may help avoid doing unwanted biopsies.

In this study, we categorized the elasticity patterns using a 5-point scale provided by Alam *et al* [12] thereby, LNs exhibiting types 1 and 2 of elastography patterns were classified as benign, but types 3, 4, and 5 of elastography patterns were classified as malignant. Nearly 80.9% of benign LNs (n = 36) had patterns 1 and 2, while nearly 90.9% of malignant LNs (n = 50) displayed patterns 3, 4, and 5. In our study, we also estimated the strain ratio using a cut-off of 1.5, which results in a very high specificity of approximately 93.0% for identifying malignant nodes. This correlated well with the study done by Lyschchik *et al* (2007) [4], where they demonstrate a specificity of 98% using a strain ratio cut-off value of 1.5.

Conclusion

In our study, there was a statistically significant difference between benign and malignant CLN for every B-mode parameter (with the exception of lymph node margin) and vascularity. Among them, color Doppler vascularity was shown to have the lowest sensitivity (80.4%) and diagnostic accuracy (70%) and the highest sensitivity (85.4%) and diagnostic accuracy (84.0%) for fatty hilum. Improved sensitivity (88.1%) and accuracy for diagnosis (85%) were obtained when all USG measures were used together. A strain ratio (SR) cut-off of 1.5 was used in the current study of elastography evaluation, which demonstrated a sensitivity of 87.2%, specificity of 93.3%, and diagnostic accuracy of 90%. Together, the SI and elastography pattern demonstrated a 94% diagnostic accuracy, 94% specificity, and 93% sensitivity. When combined with USG, an elastography pattern and cut-off SI of 1.5 can effectively differentiate between benign and malignant CLN, eliminating the need for pointless invasive procedures and treatments.

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