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SONO-ELASTOGRAPHY IN CHARACTERIZATION OF SUSPICIOUS CERVICAL LYMPH NODES AND CORRELATING WITH HISTOPATHOLOGY.

Radiodiagnosis

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ABSTRACT

Introduction: Palpation is an age-old method used to assess soft tissue abnormality based on difference in elasticity of the tissues. This is based on the fact that abnormal tissues (malignant) tend to be harder than the normal tissue. Elasticity is the ability of the material to resume its original size and shape after applying a deforming force or stress. Pathological changes in the tissue lead to change in elasticity. Elastography is an imaging modality which can assess the changes in elasticity of the tissue due to pathological process. It is used to differentiate benign and malignant cervical lymph nodes (LNs) based on colour scale, elasticity scores, strain ratio and compared to the findings with histopathological results. **Aims & Objective:** To perform and correlate B-mode ultrasonography, colour doppler imaging, and elastography of cervical lymph nodes with histopathological findings. **Methods And Materials:** The stiffness of the tissues was coded in different colors that ranged from blue for the components with no strain (hard) and red for components with the greatest elastic strain (Soft). Real time elastography is done on patients having enlarged cervical lymph nodes confirmed on B mode ultrasound. This is represented as a color coded image superimposed on the B-mode image. Sono-elastography score is calculated using Alam et al1 study which includes 5 patterns. Elastography findings are further correlated with histopathology which is considered as gold standard. **Results:** We evaluate the size, shape, echogenicity, and hilum on the B-mode images. Doppler Ultrasonography evaluation of nodal vascular pattern was of high sensitivity & specificity. The calculated sensitivity of elastographic pattern and scoring was 86%, specificity was 97%, PPV and NPV were 92% and 87% respectively, and the total accuracy was 94%. The mean elastographic strain ratio for malignant LNs (3.4 ± 1.2) was significantly greater than that for benign LNs (mean, 1.2 ± 0.3). **Conclusion:** Real time ultrasound elastography is a promising imaging technique that is useful in differentiating benign and malignant cervical lymph nodes and can reduce the rate of biopsies because of its high elasticity being highly associated with benign cytology.

KEYWORDS

INTRODUCTION

Ultrasound elastography has been introduced as a non-invasive imaging technique for evaluating cervical lymph nodes.

US elastography may be useful in differentiating benign and malignant cervical lymph nodes, thereby helping in making decisions to perform a biopsy and facilitating follow-up.

The application of strain elastography is based on the fact that stiff tissues tend to deform less and show less strain than compliant tissues when the same force is applied. In general, metastatic lymph nodes demonstrate higher stiffness than benign lymph nodes.

Manual compression is applied by the operator using ultrasound transducer. This is usually used for superficial structures like lymph nodes.

In strain elastography, the amount of displacement produced in the lesion by transducer or the physiological movement of the patient is compared to that in normal surrounding tissue. Five patterns are described on elastograms by Alam et al[1] for characterizing the lymph nodes based on the distribution and percentage of blue area (hard) .

Table 1

Pattern	Score	Description	Elastographic diagnosis
1	2	Absent or very small blue area(s)	Benign
2	4	Small scattered blue areas, total blue area < 45%	Benign
3	6	Large blue area(s), total blue area ≥ 45%	Malignant
4	8	Peripheral blue area and central green area, suggesting central necrosis	Malignant
5	10	Blue area with or without a green rim	Malignant

AIMS & OBJECTIVE

To perform and correlate B-mode ultrasonography, colour doppler imaging, and elastography of cervical lymph nodes with histo pathological findings.

MATERIALS AND METHODS

This prospective study was conducted in the Department of Radio-diagnosis at Kempegowda Institute of Medical sciences hospital and research institute, Bangalore including 50 patients with enlarged cervical lymph nodes which included Level I (submental nodes), Level II (upper jugular group), Level III (middle jugular group) , Level IV (lower jugular group), Level V (posterior triangle group) and Level VI (pre-laryngeal and pre-tracheal).

Inclusion criteria: All the patients with enlarged cervical lymph nodes who are referred for ultrasonography.

Exclusion criteria: a) Patients who have received radiotherapy/ chemotherapy. **b)** Patients who underwent recent lymph node FNAC/biopsy.

All patients were subjected to the following: 1) informed consent was taken from all patients . 2) Evaluation of the affected lymph nodes.

We evaluate the affected LN for the size and shape (the short axis / long axis ratio), the cutoff values of short axis diameter & S/L axis ratio for the best accuracy. The lymph node hilum, which was classified either as normal (if present centrally), or abnormal (absent).

Doppler evaluation

Color Doppler study for assessment of lymph node vasculature, according to Lyshchik et al[2]. , benign lymphnodes tend to show hilar vascularity or may be avascular (Pattern I) . While, metastatic nodes had peripheral or mixed (both peripheral & central) vascularity (Pattern II & III)

Real time/strain elastography was done on patients having enlarged cervical lymph nodes confirmed on B mode ultrasound. Pressure is applied using the hand held US transducer (L12-5) . This is represented as a colour coded image (Table 1) superimposed on the B mode image displayed next to it on the screen, colour score is assigned based on Sono-elastography scoring by Alam et al[1] (Table 1). A rectangular region of interest is placed on the lesion and other in the surrounding normal tissue at the same level; strain ratio is calculated, is used as a cutoff to distinguish between benign and malignant lymph nodes. The histopathological results from the biopsies was performed on the studied lesions considered as the gold standard, so as to increase the specificity of the results.

RESULTS

This study was prospectively carried on 50 patients with enlarged cervical lymph nodes. Detailed description for the number and percentage for each pathological cervical lymph node within benign and malignant categories are illustrated in the following (Table 2 and Chart 1).

B-mode sonography

We evaluate the affected LN for the size, shape; echogenicity, and hilum. With respect to the size , the short axis was more accurate than long axis in differentiating benign from malignant LNs. For the (S/L) ratio, the benign nodes was less than 0.5, while malignant LNs tend to be rounded with (S/L) ratio was more than 0.5. 80% of the benign nodes and 93.3% of malignant nodes tend to be hypoechoic. 80% of benign nodes had preserved hilum, while 93.3% of malignant nodes appeared with lost hilum. Categories are illustrated in Table 3.

Doppler findings

The distribution of the LN vascular pattern categories for benign and malignant LN are demonstrated in Table 4 and Chart 2. The benign LNs show hilar vascularity in 30 LNs and avascular pattern in 5 LNs, metastatic LNs show peripheral vascularity in 9 LNs, mixed vascularity in 2LNs and avascular pattern in 3 LNs while in lymphoma 1 LN shows mixed pattern, 1 LN shows avascular pattern.

Detailed description for the number and percentage for each pathological cervical lymph node within benign and malignant categories are illustrated in the following (Table 2 and Chart 1).

Elastographic findings

LNs of pattern 1 & 2 that scored 2 and 4 were considered benign with total number 37 LNs, whereas LNs of pattern 3, 4, & 5 that scored 6, 8 & 10 were considered malignant with total number 13 LNs. The distributions of elasticity pattern and scoring for examined benign and malignant LNs are shown in Table 5 and Chart 3.

3.4.1. Elastographic strain ratio (strain index)

It was found that the mean strain ratio for malignant LNs (mean 3.4 ± 1.2) was significantly greater than that for benign LNs (mean 1.2 ± 0.3). Illustrated in Table 6.

Table 7 and Chart 4 shows Comparison between the diagnostic performance of B-mode sonography, Doppler & Sono-elastography score and strain ratio of scanned lymph nodes.

DISCUSSION

Sono-elastography, as a noninvasive imaging modality, can potentially help in differentiation of benign and malignant LNs by reducing the number of unnecessary biopsies[4].

Our study included 50 patients (35/50 benign, 13/50 metastatic and 2/50 lymphoma) with high sensitivity of USE (86%) and high accuracy (94%) which was in agreement with Lo et al[3]., Lyshchik et al[2] ., Alam et al[1]. and Kurt et al[4].

Several studies have been reported on the US diagnostic criteria for differentiation between benign and malignant LNs. The size of LNs, shape (S/L ratio), presence or absence of hilum, calcification and echogenicity are the used criteria, however, most of them are of low specificity and low sensitivity [5.] In the study of Mahrokh et al. [10], the parameters related to minimal and maximal axis diameter had the highest sensitivity (85%), while in our study we found that the size of lymph nodes was not an accurate method for differentiating benign from malignant LNs, as generally malignant LNs were mainly larger; however inflammatory nodes tend to be as large as malignant nodes, which was in accordance with the results of Lakshmi et al[6]. The shape of LNs (S/L ratio) showed high accuracy of 90% higher than in Lyshchik et al[1]. and Mahrokh et al[7]. studies with S/L axis ratio greater than 0.5 in malignant LNs, while benign LNs tend to be elliptical in shape with S/L axis ratio less than 0.5. As in 40 LNs out of 50 S/L ratio of examined LNs was less than 0.5. Out of them 35 were pathologically benign (True negative), while the remaining 5 LNs were pathologically malignant (False negative). While in 10 LNs out of 50 S/L ratio of examined LNs was greater than 0.5 all were pathologically malignant (true positive).

Among the US criteria, the presence of hilum- in our study- showed an accuracy (84%), and sensitivity (80%). We also found that, there were many over-laps in US diagnostic criteria of benign and malignant LNs. Regarding vascular distribution it has been reported that power Doppler ultrasonographic evaluation of the vascular pattern of cervical LNs is highly reliable with a reliability of 85% Ying et al[8]. In our work Doppler ultrasonographic evaluation of nodal vascular pattern was of low sensitivity (73%), specificity (100%) and accuracy was (92%) for differentiating malignant and benign nodes. These results were similar to Arda et al[5.] which revealed that Doppler US had low sensitivity (78.9%) and high specificity.

Elastography can generally be classified into qualitative and quantitative assessments. In our study, we used the qualitative criteria suggested by Alam et al[1]. who used a 5-pattern color scoring system which based on the percentage and distribution of area with high elasticity in the cervical LNs.

In our study after revising cytological results out of 36/50(72%) LNs diagnosed as benign by elastographic scoring 34/36 (94.4%) were proven cytological to be benign (true negative) and another2/37(5.4%) LNs were proven pathologically to be malignant (false negative) (one of them was confirmed to be lymphoma while the other one was metastasis from nasopharyngeal carcinoma).

While after revising cytological results 37/50 (74%) diagnosed as benign by elastography scoring, 35/37 (94.5%) LNs confirmed to be benign by pathology (true negative). We found the overall accuracy of real-time elastography to be 96%, which is higher than all B- mode criteria (92%) and higher than color Doppler ultrasound. On the other hand, Lo et al[3]. in a study included 131 patients, found that the elasticity pattern system had sensitivity of 66.7%, specificity of 57.1%, the positive predictive value was 52.2% and the negative predictive value was 71.0%. They concluded that elastography offers no additional value over conventional ultrasound in predicting malignancy in cervical Lns.

Strain ratio greater than 1.5 had high sensitivity (86%), high specificity (100%) and accuracy of (96%). High specificity is the greatest advantage of elastography, which has been found not only in our study but also in other studies [1,2,3,4,5,8]. Different cutoff values of strain index were suggested to differentiate between benign and malignant nodes (1.5 and 1.78) [1,2] while the cutoff value used in Arda et al[5] . was 2.5. In our study the used cutoff value was 1.5 and after revising the cytological results, the calculated sensitivity was 86%, specificity was 100%, PPV was 100%. NPV was 94% and accuracy was 96%. High specificity is the greatest advantage of elastography, which has been found not only in our study but also in other studies like Lyshchik et al[2]. So, the elastography can reduce the number of unnecessary biopsy in the diagnosis of metastatic cervical lymph node.

CONCLUSION

Elastography has fairly high accuracy to differentiate between benign/malignant enlarged cervical lymph nodes.

Ultrasound elastography is an easy, non-invasive and fast imaging technique that can help in differentiating enlarged cervical lymph nodes in USG neck examination to identify cases for fine needle aspiration , thus reducing the number of unnecessary biopsies and subsequently thereby reducing risk and cost for the patient.

he calculated sensitivity of elastographic pattern and scoring was 86%, specificity was 97%, PPV and NPV were 92% and 87% respectively, and the total accuracy was 94%. The calculated sensitivity of elastographic strain ratio was 86%, specificity was 100%, PPV and NPV were 100% and 94% respectively, and the total accuracy was 96%.

Table 2 The number and percentage of patients regarding final cytological result of the enlarged lymph nodes.

Final cytological diagnosis of enlarged cervical lymph nodes	Number and percentage Of patients
Non specific lymphadenitis	16 (32%)
Granulomatous lymphadenitis	19 (38%)
lymphoma	2 (4%)
Metastasis from thyroid carcinoma	7 (14%)
Metastasis from nasopharyngeal carcinoma	6 (12%)
TOTAL	50 (100%)

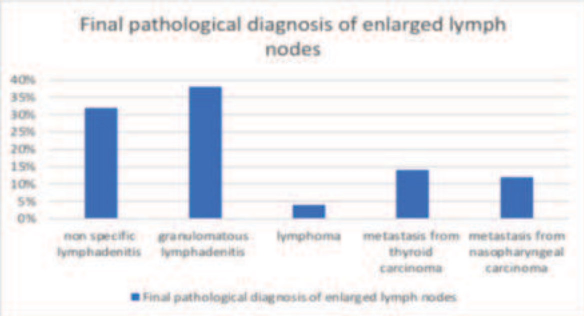


Chart 1. The number and percentage of patients regarding final cytological result of the enlarged lymph nodes.

Table 3 Size and shape of the examined lymph nodes.

	Group I (Benign) n=35 (n) (%)	Group II (malignant) n=50 (n)(%)	P value	Accuracy
Nodal size short axis				
≤0.8 mm	28 (80%)	9 (60%)	0.004	74%
>0.8 mm	7 (20%)	6 (40%)		
Nodal shape S/L ratio				
≤0.5 mm	35 (100%)	5 (33.3%)	0.000	90%
>0.5 mm	0 (0%)	10 (66.6%)		
Echogenicity				
Normal	7 (20%)	0	0.1	70%
Hypoechoic	28 (80%)	14(93.33%)		
Anechoic	0	1 (6.66%)		
Hilum				
preserved	28 (80%)	1 (6.66%)	0.000	84%
absent	7 (20%)	14(93.33%)		

Table 4 Relationship between histopathology and vascularity among the studied groups.

	Granulomatous Lymphadenitis (N=19)	Non specific lymphadenitis (N= 16)	Metastatic involvement (N=13)	Lymphoma (N=20)
Avascular	3 (15.8%)	2 (12.5%)	2 (15.4%)	1 (50%)
hilar	16 (84.2%)	14 (87.5%)	0	0
Mixed	0	0	2 (15.4%)	1 (50%)
peripheral	0	0	9 (69.2%)	0

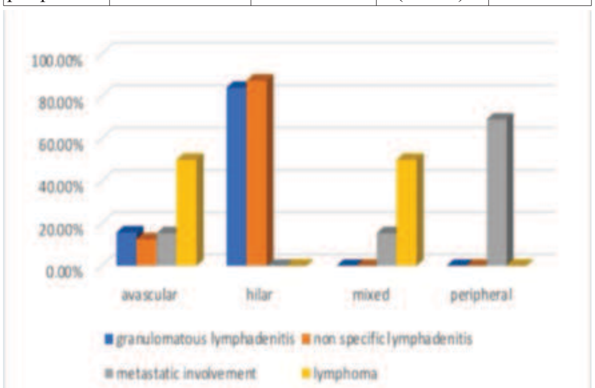


Chart 2. Distribution of vascular pattern.

Table5 The distributions of elasticity pattern and scoring for examined benign and malignant LNs are shown in the table.

Elastography Pattern	Elastographic scoring	Benign n=35	Malignant n=15	percentage
1	2	7	0	14%
2	4	28	2	60%
Benign	(2,4)			74%
3	6	0	7	14%
4	8	0	4	8%
5	10	0	2	4%
malignant	(6,8&10)			26%

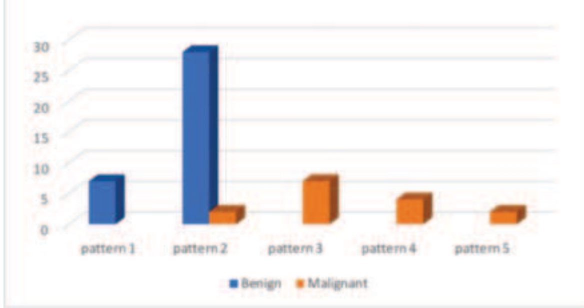


Chart 3. The distributions of electrographic pattern for benign and malignant Lns.

Table 6 Comparison Between The Studied Groups As Regard To Strain Ratio.

	Group I Benign (35)		Group II Malignant (15)		Test of significance	P value
	n	(%)	n	(%)		
Strain ratio						
≤ 1.5	32.	(64%)	5.	(10%)	t=5.6	0.000
>1.5	3.	(6%)	10.	(20%)		

Table 7 Comparison between the diagnostic performance B-mode sonography, Doppler, sono-elastography score and strain ratio of scanned lymph nodes.

	TP	FN	TN	FP	SENSITIVITY	SPECIFICITY	PPV	NPV	ACCURACY
B MODE US	13	2	33	2	86%	94%	86%	94%	92%
DOPPLER US	11	4	35	0	73%	100%	100%	89%	92%
ES SCORE	13	2	34	1	86%	97%	92%	87%	94%
ES STRAIN RATIO	13	2	34	1	86%	100%	100%	94%	96%

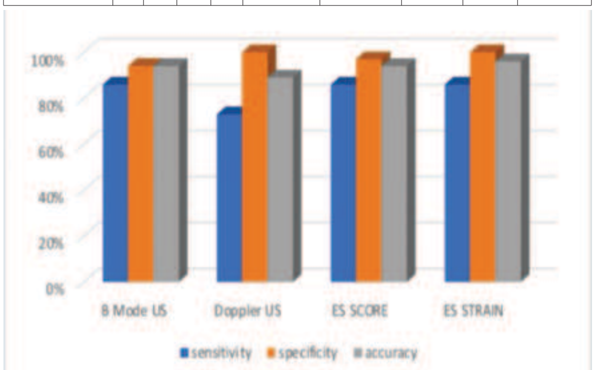
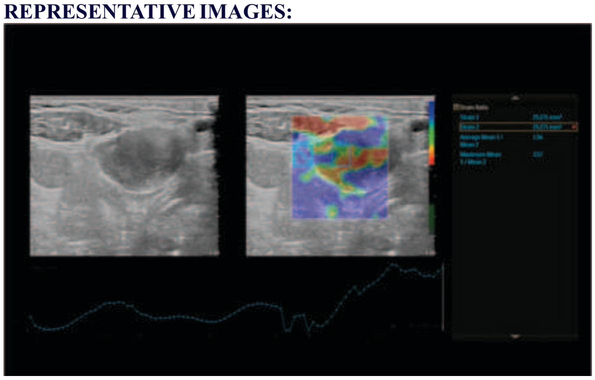
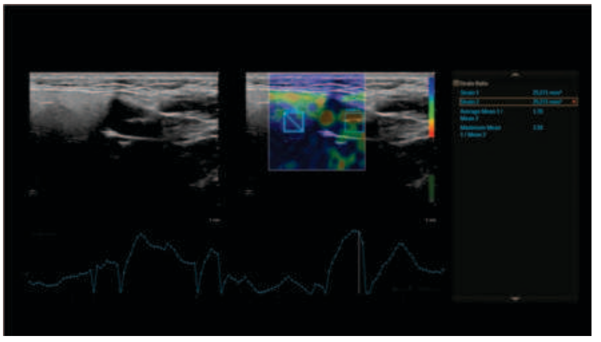


Chart 4. Comparison between the diagnostic performance B-mode sonography, Doppler, sono-elastography score.

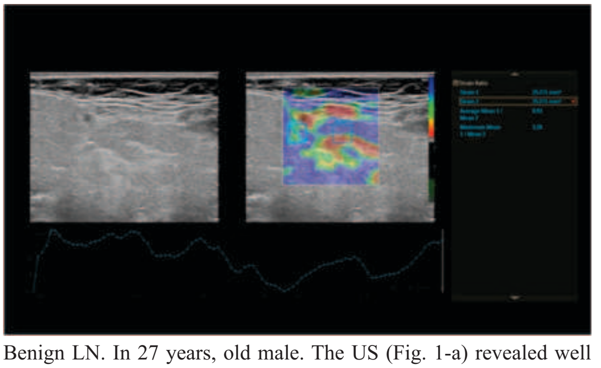
REPRESENTATIVE IMAGES:



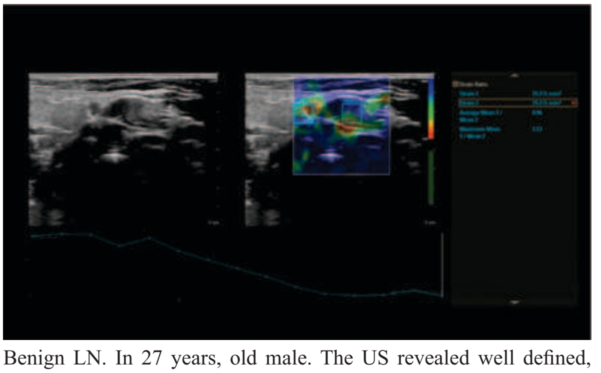
Lymphoma, in 56 years, old female. The US revealed well defined, hypoechoic, rounded shaped left upper deep cervical LN without hilum, S/L ratio was 0.55. The US elastogram (Fig. 3-c) of the LN revealed type 3 color pattern with blue area more than 45%, score 6, strain index value was 1.56 & final histopathological diagnosis was lymphoma.



Metastatic LN, in 56 years, old male with nasopharyngeal carcinoma. The US revealed well defined, hypoechoic, right lower deep cervical elliptical LN with hilum, S/L ratio was 0.32. The US elastogram of the LN revealed type 3 color pattern with blue area more than 45%, score 6, strain index value was 1.70 & final histopathological diagnosis was metastasis.



Benign LN. In 27 years, old male. The US (Fig. 1-a) revealed well defined, iso-hypoechoic, elliptical right upper deep cervical LN with preserved hilum, S/L ratio was 0.36. The US elastogram of the LN revealed type 2 color pattern with scattered blue areas less than 45%, score 4, strain index value was 0.93 & biopsy revealed nonspecific lymphadenitis.



Benign LN. In 27 years, old male. The US revealed well defined, hypoechoic, elliptical right upper deep cervical LN with preserved hilum, S/L ratio was 0.36. The US elastogram of the LN revealed type 2 color pattern with scattered blue areas less than 45% , score 4 , strain index value was 0.96 & biopsy revealed nonspecific lymphadenitis.

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