



Diagnostic Accuracy of Elastography to Differentiate Between Benign and Malignant Lymph Nodes of Head and Neck Region Taking Histopathology as Gold Standard

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ABSTRACT

Objective: To find out diagnostic accuracy of elastography to discern malignant from benign lymph nodes of head and neck region while the histopathology remains as gold standard. **Study Design:** This was a cross-sectional study. **Place and Duration of Study:** The study was conducted in Combined Military Hospital Multan over a period of eight months from September 2024 to April 2025. **Methodology:** Patients of either gender with enlarged (≥ 10 millimeter) lymph nodes presenting to radiology department were selected and subjected to elastography strain index measurement. Lymph nodes with this value ≥ 2 were categorized as malignant. Biopsy sample was taken from all under study lymph nodes and subjected to histopathology which confirmed or rejected the validation of elastography strain index measurement. **Results:** The mean age of the participants turned out to be 37.4 ± 15.1 years. Mean BMI was 25.7 ± 2.2 kg/m². Elastography strain index had diagnostic accuracy of 87.5%, sensitivity, specificity, Positive Predicted Value and Negative Predicted Value were 81.43%, 94.83%, 95% and 80.88% respectively. **Conclusion:** Elastography strain index measurement is a reliable yet noninvasive modality to discern malignant from benign cervical lymph nodes. It should be used as a valuable adjunct to other already prevailing ultra-sonographic modalities

INTRODUCTION

Lymph nodes (LN) filter or trap elements such as viruses, bacteria and atypical cells ¹. Amongst head and neck LN, cervical lymph nodes are easily palpable when enlarged which can be secondary to benign or malignant causes. Infection is the commonest cause of head and neck lymphadenopathy². The prevalence of malignant lymphadenopathy in head and neck is 55% ³. The location and characteristics of the lymph nodes can provide important clues regarding the underlying cause. In cases where a malignancy is suspected, imaging techniques like ultrasound, computed tomography (CT) scan, magnetic resonance imaging (MRI) are helpful ⁴. Another such non-invasive investigation that has recently gained popularity to discern amongst benign and malignant lymph nodes is elastography ^{5,6}. However, studies that have focused on its diagnostic accuracy have yielded variable results. A study including 78 patients with a mean age of 38 ± 12.8 years reported 58.97% benign lymph nodes whereas 41.03% were malignant. It stated that specificity, sensitivity and diagnostic accuracy of elastography to distinguish amongst benign and malignant LN was 97%, 83% and 89%, respectively ⁷. In another study that including 50

patients with a mean age of 30.50 ± 8.95 years, they found that benign LN were 58% and malignant LN were 42% and the stated sensitivity, specificity and diagnostic accuracy of elastography was 83.33%, 96.42% and 94.0%, respectively ⁸. Contrarily, higher sensitivity was found in another study which including 96 patients having a mean age of 41.06 ± 6.67 years and it was reported that sensitivity, specificity, PPV, NPV and diagnostic accuracy of elastography at 92%, 89.10%, 92.80%, 89.40%, and 94%, respectively ⁹.

Since all enlarged LN of head and neck are not malignant, it means that invasive tests should not be performed in all the patients. However, in reality, practice is otherwise. This may be due to lack of availability of cheaper and reliable modality of investigation that can differentiate amongst malignant and benign nature of enlarged lymph nodes. One of the investigations, in this regard, has gained recent popularity owing to its low cost and easy accessibility is elastography. For this purpose, we planned to conduct this study to find out the diagnostic accuracy of elastography to discern malignant from benign lymph nodes of head and neck region while keeping the histopathology as a gold standard. The findings of this

study will not only address the discrepancy in the existing literature but will also support the validity of this less expensive, non-invasive, and easily accessible investigation to determine whether an enlarged lymph node is malignant while avoiding invasive procedures like FNAC and histopathology in benign cases. This will prevent patients from needlessly undergoing unnecessary surgery and save money on additional histopathology tests.

METHODOLOGY

This research was conducted in Department of Radiology over a period of eight months from from September 2024 to April 2025 after due permission from hospital ethical committee vide number 98/2024. Calculation of the sample size was done by using WHO sample size calculator while considering the Confidence level at 95%, Absolute precision at 10% and assuming the Prevalence of malignant LN 42%⁸, Sensitivity 83.33%⁸ and Specificity 96.42%⁸. Calculated sample size was 129.

Inclusion Criteria

Patients of both genders aging between 16 and 75 years referred to radiology department with suspicious malignancy for ultrasonographic assessment of enlarged LN in head and neck region were included.

Exclusion Criteria

Patients with already diagnosed malignancy or already categorized (benign/ malignant) enlarged lymph nodes who presented for follow up were excluded from the study. Patients who could not consent to procedure, tuberculosis cases and patients on phenytoin (causing enlargement of LN) were also excluded.

Basic characteristics counting gender, body mass index kg/m² (BMI), age and LN size (in mm) were documented. Ultrasonographic assessment was done by consultant radiologist having five years post fellowship experience. Size of lymph node was measured in millimeters (mm) by consultant radiologist using ultrasound machine measuring function which was marked in between two points in the longest axis. A LN was labelled as enlarged if the size in longest-axis diameter was ≥ 10 mm. Any enlarged lymph node with longest-axis diameter ≥ 10 mm was subjected to ultrasound elastography to assess its elastography strain index (ESI). ESI is the ratio of the solidity of the LN in respect to neighboring normal tissue¹⁰. The first area of interest (ROI 1) was taken as the LN and the second area of interest (ROI 2) was taken as the neighboring muscle at the equivalent level. The ESI was measured as the ratio of ROI 1 to ROI 2 measurements. The cut-off ESI value was set at 2.0. LN was labelled as benign if ESI is < 2.0 while if ESI is ≥ 2.0 LN was labelled as malignant. The enlarged LN were subjected to histopathological examination; excision biopsy specimen was obtained by consultant surgeon under radiological guidance and then sample sent to in-hospital histopathology laboratory where consultant pathologist decided on the nature of the LN as benign or malignant based on histology findings.

The data was analyzed using SPSS software 25. Quantitative variable (age, BMI and LN size) was expressed as mean \pm standard deviation. The categorical

variables (gender, LN status on ESI and histopathology) was represented as frequency and percentages. A 2x2 table, was drawn in order to determine sensitivity, specificity, negative predictive value, positive predictive value and accuracy of elastography keeping histopathology a gold standard. (Table 1)

Table 1

2x2 Table for Sensitivity, Specificity, PPV, NPV and Accuracy

Elastography Strain Index	Malignant LN on Histopathology	Benign LN on Histopathology
ESI ≥ 2.0	TP	FP
ESI < 2.0	FN	TN

RESULTS

All the enrolled one hundred and twenty-nine patients completed trial. The mean age of the patients turned out to be 37.4 \pm 15.1 years. Calculated male to female ratio was 1.19:1, details of the basic parameters of the patient's profiles given in table 2.

Table 2

Details of Basic Parameters

Parameter	Mean \pm SD	Range
Age (years)	37.4 \pm 15.1	16-74
Lymph Node Size (mm)	14.01 \pm 2.30	10-19
BMI	25.7 \pm 2.25	23-31

Based on ESI findings 52.7% of the patients were labelled as benign whereas 46.5% were labelled as malignant. Histopathology confirmed 45.7% and 54.3% as benign and malignant respectively. Based on the derived data a 2x2 table is made as table 3.

Table 3

Elastography Strain Index versus Histopathology

Elastography Strain Index	Malignant LN on Histopathology	Benign LN on Histopathology
ESI ≥ 2.0	TP=57	FP=3
ESI < 2.0	FN=13	TN=55

The model correctly identified 81.3% of the positive cases and correctly classified 94.83% actual negative cases. This study demonstrated ESI can make correct predictions with an accuracy of 87.5%, details as per Table 4.

Table 4

Diagnostic Accuracy of Elastography Strain Index

Index	Value
Sensitivity	81.43%
Specificity	94.83%
Positive Predicted Value	95%
Negative Predicted Value	80.88%
Diagnostic Accuracy	87.5%

DISCUSSION

The gold standard of classification in this study was histology-based although we evaluated the investigative precision of ultrasound elastography for distinguishing amongst the benign and malignant lymph nodes of the head and neck region. The results of our investigation demonstrated that ultrasound elastography had

exceptional diagnostic accuracy of 87.5% in distinguishing amongst the benign and malignant LN with sensitivity at 81.43% and specificity at 94.83%. The sensitivity, specificity, and overall accuracy of elastography depend on the type of elastography used ¹¹, the experience of the operator, and the specific lymph node location ¹².

As per Kanagaraju V et al, ¹³ the majority of the benign nodules had ESI value 1 or 2, histopathology was kept as gold standard and found out that ESI is 94.1% sensitive, 93.9% specific with a diagnostic accuracy of 94%. These results are similar with our study; the minor differences may be due to different ultrasound machines and operator's experience. The results of this trial are relatable to Yadav et al ¹⁴ which studied 70 cervical lymph nodes under ESI parameter and found out that it is 94.3% specific and 85.7% accurate.

The result of our study found out that 44.1% LN were malignant that is in line with the results of Abdelgawad et al ¹⁵ showing 42.8% malignancy in enlarged cervical LN. FNAC (Fine Needle Aspiration Cytology), an invasive procedure, is stated to have a sensitivity of 82% and a specificity of 97% for assessing cervical lymph nodes ^{16,17}. In contrast, ultrasound elastography, which is non-invasive, may help reduce the need for unnecessary biopsies in patients by providing supportive diagnostic information ^{18,19}.

Ameta analysis of 1420 patients published in 2021 by Mengjie Wu et al ²⁰ found out that diagnostic ability of ESI is 82% sensitive and 80% specific with 95% confidence

interval. Our study resulted in consistent findings to their study. Another review article by Wang B et al ²¹ advocates the utility of ESI as a reliable modality to confirm the malignant/ benign status of superficial LN with a range of accuracy from 64% to 99%, although our ESI accuracy result is consistent with it but the varied range is probably due to subjective and user dependent nature of the ESI.

Maurizio Ce et al ²² highlights the incorporation of artificial intelligence (AI) tools that could potentially address some of the major limitations of elastosonography, such as its reliance on the operator's skill and its low specificity. This could facilitate the seamless integration of elastosonography into clinical workflows, enhancing its overall effectiveness.

CONCLUSION

Elastography strain index measurement is a reliable yet noninvasive modality to discern malignant from benign cervical lymph nodes. It should be used as a valuable adjunct to other already prevailing ultra-sonographic modalities.

Limitation: Operator dependent bias could also not be ruled out. Further randomized controlled trials with larger sample size and over a longer duration may help in establishing authentic results.

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