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Assessment of Cervical Lymphadenopathy by Ultrasonography and Its Correlation with FNAC

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Abstract

Background: Cervical lymphadenopathy represents a frequent clinical problem with causes ranging from benign inflammatory conditions to malignant disorders. Precise characterization is crucial to determine appropriate management and to reduce unnecessary invasive procedures. Ultrasonography has been shown to be superior to clinical palpation in detecting and evaluating cervical lymph nodes.

Objective: To assess cervical lymph nodes using gray-scale ultrasonography, colour Doppler imaging, and elastography, and to correlate sonographic findings with fine-needle aspiration cytology (FNAC).

Materials and Methods: This prospective observational study included patients presenting with cervical lymphadenopathy who underwent ultrasonographic evaluation. Gray-scale morphological features, Doppler vascular patterns, and elastographic strain ratios were documented and compared with FNAC or histopathological results.

Results: Reactive lymphadenopathy constituted the most common benign diagnosis. Malignant lymph nodes were more frequently round, demonstrated loss of echogenic hilum, heterogeneous echotexture, sharp margins, peripheral or mixed vascularity, and increased stiffness on elastography. Combined assessment using B-mode ultrasound and elastography yielded higher diagnostic accuracy than gray-scale imaging alone.

Conclusion: Ultrasonography supplemented with colour Doppler and elastography is a reliable, non-invasive modality for evaluating cervical lymphadenopathy. The integration of multiple sonographic parameters significantly improves differentiation between benign and malignant lymph nodes when correlated with FNAC findings.

Keywords: Cervical lymphadenopathy, Ultrasonography, Colour Doppler, Elastography, FNAC

Introduction

Imaging plays a vital role in the evaluation of head and neck pathologies, particularly in the assessment of soft-tissue structures such as lymph nodes, muscles, and vascular components. Cervical lymphadenopathy is commonly encountered in clinical practice and may arise due to infections, inflammatory conditions, granulomatous diseases such as tuberculosis, or malignancies including lymphoma and metastatic disease.

Each pathological entity produces characteristic alterations in lymph node morphology and vascular architecture. High-resolution ultrasonography, combined with colour Doppler imaging, allows detailed evaluation of these features owing to the

superficial location of cervical lymph nodes. Compared to computed tomography and magnetic resonance imaging, ultrasound offers superior spatial resolution for superficial structures, lacks ionizing radiation, and is cost-effective.

Important sonographic parameters include nodal size, shape, short-to-long axis ratio, echogenic hilum, internal echotexture, margins, and vascular pattern. Accurate interpretation of these features aids in distinguishing benign from malignant lymphadenopathy, thereby reducing the need for unnecessary invasive diagnostic procedures.

Methodology

On 100 individuals with enlarged cervical lymph nodes, the study was conducted from 1st June 2024 to 31st May 2025 for a period of 1 year in the Department of, Saraswathi institute of medical sciences, Hapur. 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. Cervical lymphadenopathy was assessed using Gray-scale ultrasonography and colour Doppler imaging.

Method of Collection of Data

Patients with suspected cervical lymphadenopathy underwent Gray-scale and colour Doppler ultrasonography using Siemens (Accuson X-300) or Philips HD-15 systems, equipped with a 7–10 MHz linear probe. The scanning technique was adjusted according to patient characteristics when necessary.

Morphologic evaluation included measurement of the short-to-long axis (S/L) ratio and assessment of the echogenic hilum. Doppler evaluation documented vascular patterns as central, peripheral, mixed, or avascular.

Ultrasonographic findings were compared with cytological or histopathological diagnoses, which served as the reference standard.

Lymph node morphology was assessed on Gray-scale ultrasonography, while vascular characteristics were evaluated using colour Doppler imaging (CDI). The B-mode parameters analysed included short-axis diameter (cut-off value: 8 mm), short-to-long axis ratio (cut-off value: 0.6), presence or absence of echogenic fatty hilum, and nodal margin characteristics (regular or irregular).

Based on Doppler vascularity, lymph nodes were categorized into five patterns: Pattern 1—hilar vascularity or absent flow; Pattern 2—peripheral vascularity; Pattern 3—mixed vascularity; Pattern 4—absent vascularity; and Pattern 5—displaced hilar vascularity. Patterns 1, 4, and 5 were considered indicative of benign lymph nodes, whereas patterns 2 and 3 were regarded as suggestive of malignancy.

Strain elastography was conducted using a standardized free-hand compression–decompression technique with real-time quality monitoring. Compression was applied perpendicular to the skin surface with minimal lateral movement until a stable elastography image was obtained.

Imaging Parameters Assessed

Gray-Scale Ultrasound

1. Size and number of lymph nodes
2. Shape (Short axis / Long axis ratio)
3. Border definition
4. Echogenic hilum
   - Echotexture
   - Presence of necrosis and matting
5. Colour Doppler
   - Central (hilar) vascularity
   - Peripheral vascularity
   - Mixed vascularity
   - Avascular pattern
6. Elastography
   - Elastography pattern (soft → hard)
   - Strain ratio (lymph node vs adjacent muscle)
   - Strain ratio >1.5 considered suspicious for malignancy
7. FNAC samples were sent to the Department of Pathology for interpretation. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy of various sonographic features and Doppler parameters were calculated using contingency tables.

Results

The study population ranged in age from 7 to 78 years, with a mean age of 40.9 ± 16.9 years. Females constituted 55% of the cohort, while males accounted for 45%. Histopathological analysis revealed 45 benign and 55 malignant lymph nodes.

Among benign lesions, tuberculous lymphadenitis was the most common diagnosis, followed by reactive lymphadenitis. Metastatic lymphadenopathy and lymphoma were the predominant malignant causes. A statistically significant association was observed between malignant lymph nodes and a short-to-long axis ratio greater than 0.6, absence of echogenic hilum, abnormal vascular patterns on colour Doppler, and increased stiffness on elastography.

Elastography demonstrated high diagnostic performance, with malignant lymph nodes showing significantly higher strain ratios compared to benign nodes. Combined evaluation using B-mode ultrasonography and elastography further enhanced diagnostic accuracy.

Table 1: Gray-scale Ultrasound Features

Parameters	Bening Nodes	Malignant Nodes
Shape (S/L) ratio	Oval (<0.5)	Round (>0.5)
Echogenic hilum	Preserved	Absent
Echotexture	Homogenous	Heterogenous
Borders	Unsharp	Sharp
Necrosis	Rare	Common

Table 2: Colour doppler Vascularity Patterns

Pattern	Benign	Malignant
Central	Predominant	Occasional
Peripheral	Rare	Common
Mixed	Rare	Common

Table 3: Elastography Findings

Feature	Benign	Malignant
Stiffness	Soft/intermediate	Hard
Strain-ratio	<1.5	>1.5

Table 4: Show the correlation of short to long axis ratio (S/L) and pathological diagnosis of lymph nodes

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	

No statistically significant difference was observed between benign and malignant lymph nodes with respect to nodal margins, intranodal necrosis, or overall echogenicity (P = 0.47, P = 0.143, and P = 0.283, respectively). Loss of echogenic fatty hilum was identified in 47 of 55 malignant lymph nodes. Evaluation of nodal shape demonstrated that 87.2% (n = 48) of malignant lymph nodes had a short-to-long axis (S/L) ratio greater than 0.6, whereas 75.5% (n = 34) of benign lymph nodes exhibited an S/L ratio less than 0.6, a difference that was statistically significant (P = 0.001).

Table 5: Shows the correlation between nodal margin and pathological diagnosis of lymph nodes

Margins	Malignant (HPE)	Benign (HPE)	TOTAL	P VALUE
	Malignant	Benign	Total	
Regular	17	17	34	0.471
Irregular	38	28	66	
Total	55	45	100	

Table 6: Shows the correlation between the colour doppler pattern and the pathological diagnosis of lymph nodes

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 7: 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 8: Shows the correlation between strain ratio and pathological diagnosis of lymph nodes

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 9: 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%	74.94 to 92.33%
Accuracy	90.00%	82.38 to 95.10%

Table 10: 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

Among the gray-scale ultrasound parameters, echogenic hilum showed the highest diagnostic accuracy (84%), while nodal border characteristics demonstrated the lowest accuracy (45%). On Colour Doppler assessment, a benign vascular pattern was observed in approximately 88% (n = 40) of benign lymph nodes, whereas 80% (n = 44) of malignant lymph nodes displayed abnormal vascular patterns, with this difference reaching statistical significance (P = 0.001).

Elastography analysis revealed that the majority of malignant lymph nodes (n = 53) demonstrated a strain ratio greater than 1.5, whereas most benign lymph nodes (n = 47) showed a strain ratio below 1.5. A higher strain ratio was found to be significantly associated with malignant histopathology (P = 0.001).

All patients subsequently underwent FNAC or biopsy for definitive diagnosis. Final pathological analysis confirmed the predominance of tuberculous lymphadenitis and reactive lymphadenitis among benign cervical lymphadenopathy, while metastatic disease and lymphoma were the principal malignant aetiologies.

Conclusion

1. High-resolution ultrasonography is an effective first-line tool for detecting cervical lymph nodes and differentiating benign, reactive, tubercular, and malignant lymphadenopathy.
2. Ultrasound is economical, non-invasive, radiation-free, and safe for evaluating cervical lymph nodes.
3. Color Doppler provides valuable insight into nodal vascularity, enhancing differentiation between benign and malignant nodes.
4. Combining Gray-scale features with Doppler vascular patterns significantly improves diagnostic accuracy.
5. Final diagnosis should always be correlated with FNAC or histopathology to determine the exact nature and histologic type of lymphadenopathy.

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