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Role of High-Resolution Ultrasonography in the Evaluation of Cervical Lymphadenopathy and its Correlation with Fine Needle Aspiration Cytology (FNAC)

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Abstract: ***Background**: Cervical lymphadenopathy is a common clinical manifestation presenting a diagnostic dilemma, especially given the prevalence of Tuberculous Lymphadenitis which can mimic malignant nodes. While Fine Needle Aspiration Cytology (FNAC) remains the gold standard for diagnosis, High-Resolution Ultrasonography (HRUS) combined with Colour Doppler offers a crucial, non-invasive first-line evaluation. **Methods**: A prospective observational study was designed to evaluate 100 patients with clinically palpable cervical lymphadenopathy over 18 months. Patients were evaluated using high-frequency linear array transducers (7.0–12.0 MHz) to assess nodal morphology and vascularity, followed by FNAC for cytological correlation. Results: [Data to be incorporated]. **Conclusion**: High-resolution ultrasound serves as an effective primary diagnostic tool for characterizing cervical lymphadenopathy, with specific morphological and vascular patterns reliably differentiating between benign, tuberculous, and malignant nodes.*

Keywords: Cervical Lymphadenopathy, High-Resolution Ultrasonography, FNAC, Colour Doppler, Solbiati Index

1. Introduction

Cervical lymphadenopathy is a frequent clinical manifestation across all age groups, acting as a common expression for a wide range of etiologies including benign reactive hyperplasia, acute bacterial lymphadenitis, chronic granulomatous diseases like tuberculosis, and neoplastic processes such as lymphoma or metastasis. Clinical examination alone, which relies on assessing size, consistency, and mobility, yields a sensitivity of only 70-75% when attempting to distinguish between benign and malignant etiologies.

While FNAC and biopsy are the established gold standards for tissue diagnosis, they are invasive and carry risks of patient anxiety, discomfort, hemorrhage, or nerve damage. High-Resolution Ultrasonography (HRUS) with Colour Doppler serves as an outstanding, affordable, and radiation-free non-invasive imaging modality for initial assessment. It enables the careful evaluation of nodal morphology- such as the Short/Long axis ratio (S/L ratio), nodal borders, and the presence of an echogenic fatty hilum- while Colour Doppler delineates vascular patterns to differentiate benign from malignant nodes.

2. Objectives of the Study

Primary Objective:
- To compare the diagnostic accuracy (Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value, and Overall Accuracy) of Ultrasonography and Colour Doppler in distinguishing between neoplastic and non-neoplastic cervical lymphadenopathy, using FNAC/Biopsy as the gold standard.

Secondary Objectives:
- To determine the morphological characteristics of cervical lymph nodes via Grey Scale USG, including size, shape (S/L ratio), nodal hilum status, nodal borders, echotexture, necrosis, and calcification.
- To assess the vascular appearances of lymph nodes (Central/Hilar flow vs. Peripheral/Mixed flow) using Colour Doppler flow imaging.
- To correlate specific sonographic patterns with pathological diagnoses.
- To determine which individual sonographic features are the most sensitive predictors of malignancy.

3. Materials and Methods

Study Design & Setting: A cross-sectional, prospective, observational study was conducted over 18 months at the Department of Radiodiagnosis, P.D.U Government Medical College and Civil Hospital, Rajkot.

Sample Size & Patient Selection: A minimum of 100 pediatric and adult cases with clinically palpable or incidentally detected cervical lymphadenopathy (short axis > 10mm) were included. Patients with a history of neck chemotherapy or radiation, open wounds over the node, or those refusing FNAC/Biopsy were excluded from the study.

Imaging Protocol: Examinations were performed using Samsung RS80 EVO and Samsung Accuvix XG ultrasound systems equipped with high-frequency linear array transducers (7.0–12.0 MHz). The scanning protocol systematically evaluated nodal levels I through VI, documenting biometry (Long and Short Axis), shape via the Solbiati Index (S/L ratio < 0.5 indicating probable benignity; > 0.5 indicating suspicion), hilum preservation, nodal borders, and internal echotexture. Colour Doppler evaluation categorized vascularity into four patterns: Pattern I (central/hilar), Pattern II (peripheral/capsular), Pattern III (mixed), and Pattern IV (avascular/spotty).

Pathological Analysis: FNAC was performed under aseptic conditions using 22-24G needles attached to a 10-20cc syringe. Smears were prepared via wet fixation (70-90% ethanol) or air drying, and stained using H&E, Papanicolaou, Giemsa, or Ziehl-Neelsen stains depending on clinical suspicion. A Bard Max Core Disposable Core Biopsy Instrument (18G) was utilized when core tissue was required.

4. Results

Table 1: Age-wise distribution of the cases

Age (in years)	No. of cases	Percent (%)
0-10	22	11
11-20	48	24
21-30	33	16.5
31-40	31	15.5
41-50	24	12
51-60	25	12.5
>61	17	8.5

Most patients belonged to the 11–20 years age group (24%), followed by 21–30 years (16.5%) and 31–40 years (15.5%). Pediatric cases (0–10 years) accounted for 11% of the study population. The least number of cases were seen in patients above 61 years (8.5%).

This distribution suggests that cervical lymphadenopathy was more prevalent in adolescents and young adults in the present study. The relatively higher incidence in younger age groups may be attributed to infective etiologies, particularly reactive and tubercular lymphadenitis, which are common in developing regions.

Table 2: Distribution of Patients According to Age and Gender

Age Group (Years)	Male (n)	Female (n)	Total (n)	Percentage (%)
0 – 10	12	10	22	11
11 – 20	23	25	48	24
21 – 30	14	19	33	16.5
31 – 40	12	18	30	15.5
41 – 50	16	8	24	12
51 – 60	14	11	25	12.5
> 61	13	5	18	8.5
Total	100	100	200	100%

The table depicts the age and gender distribution of 200 cases, comprising an equal number of males and females (100 each). The highest proportion of cases was observed in the 11–20 years age group (48 cases, 24%), followed by 21–30 years (33 cases, 16.5%) and 31–40 years (30 cases, 15.5%). Children aged 0–10 years accounted for 22 cases (11%). The 41–50 and 51–60 age groups contributed 24 cases (12%) and 25 cases (12.5%), respectively, while patients older than 61 years accounted for the smallest group, with 18 cases (8.5%). Gender distribution was relatively balanced across most age groups, with a slight female predominance in the 11–20, 21–30, and 31–40 year categories, and male predominance in the older age groups. Overall, the majority of cases were concentrated in the younger and middle-aged population.

Table 3: Distribution of Lymph Nodes According to Cervical Levels.

Nodal Level	No. of Cases (n)	Percentage (%)
Level I (Sub mental/ Submandibular)	44	22
Level II (Upper Jugular)	109	54.5
Level III (Mid Jugular)	74	37
Level IV (Lower Jugular)	34	17
Level V (Posterior Triangle)	19	8.5
Level VI (Anterior Compartment)	0	0

In the present study, the most involved nodal group was Level II (Upper Jugular), accounting for 54.5% of cases. This was followed by Level III (37%) and Level I (22%). Lower jugular (Level IV) and posterior triangle nodes (Level V) showed comparatively lesser involvement. No cases were observed in Level VI (Anterior compartment). The predominance of Level II involvement may be attributed to its extensive lymphatic drainage from the oropharynx and upper aerodigestive tract.

Table 4: Distribution of Cases According to Clinical Symptoms

Clinical Symptom	No. of Patients	Percentage (%)
Neck Swelling	200	100%
Fever	167	83.5
Pain / Tenderness	173	86.5
Weight Loss	161	80.5
Cough / Sputum	98	49

In the present study, neck swelling was the universal presenting complaint (100%). Constitutional symptoms such as fever (83.5%) and weight loss (80.5%) were highly prevalent, indicating a significant proportion of patients with chronic or infective pathology. Pain and tenderness were reported in 86.5% of cases, reflecting inflammatory involvement of lymph nodes. Nearly half of the patients (49%) presented with cough and sputum, suggesting a possible pulmonary origin or association, particularly in cases suspected of tuberculous lymphadenitis.

Table 5: Diagnosis on ultrasound

Diagnosis on USG	No. of cases	Percent (%)
Tubercular	78	39
Reactive	91	45.5
Malignancy	8	4
Metastases	23	11.5
Total	200	100

Explanation:
On ultrasonography (USG), reactive lymphadenitis was the most common diagnosis (45.5%), followed by tubercular lymphadenitis (39%). Metastatic lymph nodes accounted for

11.5% of cases, while primary malignant lymph nodes constituted 4%.

These findings indicate that benign etiologies (reactive and tubercular) comprised the majority (84.5%) of cervical lymphadenopathy cases in this study. High-resolution ultrasonography proved valuable in differentiating benign from malignant nodes based on morphological characteristics.

Table 6: Distribution of Cases According to Final FNAC/Biopsy Diagnosis

Final Diagnosis	No. of Cases	Percentage (%)
Reactive Lymphadenitis	85	42.5
Tuberculosis Lymphadenitis	75	37.5
Metastatic	31	16.5
Lymphoma	6	3
Other	3	1.5
Total	200	100

In the present study, benign etiologies were more common than malignant causes. Reactive lymphadenitis (42.5%) emerged as the most frequent diagnosis, followed closely by tuberculous lymphadenitis (37.5%), highlighting the significant burden of infectious pathology. Malignant causes accounted for 19.5% of cases (metastasis 16.5% and lymphoma 3%), indicating the importance of thorough diagnostic evaluation to exclude neoplastic aetiology in cervical lymphadenopathy.

Table 7: Comparison of USG diagnosis with FNAC diagnosis

		FNAC Diagnosis			
USG Diagnosis		Lymphoma	Tubercular	Reactive	Metastases
Lymphoma	8	7	1	0	0
Tubercular	78	1	74	2	1
Reactive	91	1	0	85	5
Metastases	23	0	2	0	21
Total	200	9	77	87	27

The table shows the correlation between ultrasonography (USG) diagnosis and FNAC diagnosis in 200 cases of cervical lymphadenopathy. Among the 8 cases diagnosed as lymphoma on USG, 7 were confirmed as lymphoma on FNAC, while 1 was diagnosed as reactive, showing good concordance. Of the 78 cases labelled tubercular on USG, 74 were confirmed as tubercular on FNAC, whereas 1 case each was diagnosed as lymphoma and metastasis, and 2 cases were reactive. Among the 91 cases diagnosed as reactive on USG, 85 were confirmed as reactive on FNAC, with 1 case reported as lymphoma and 5 cases as metastases. Of the 23 cases diagnosed as metastases on USG, 21 were confirmed on FNAC, while 2 were tubercular. Overall, FNAC diagnosed 9 cases as lymphoma, 77 as tubercular, 87 as reactive, and 27 as metastases. The findings demonstrate a high level of agreement between USG and FNAC, with minor discrepancies, indicating good diagnostic accuracy of ultrasonography in evaluating cervical lymphadenopathy.

Table 8: Distribution of L/S ratio on USG to FNAC/histopathology diagnosis

Category	L/S >2	L/S<2	Total
Reactive	1	7	8
Tubercular	61	17	78
Malignancy	62	29	91
Metastases	2	21	23
Total	132	68	200

The table illustrates the distribution of lesions based on the long-axis to short-axis (L/S) ratio among 200 cases. Overall, 132 cases demonstrated an L/S ratio >2, while 68 cases had an L/S ratio <2. Tubercular lesions (n = 78) predominantly showed an L/S ratio >2 in 61 cases, with 17 cases exhibiting an L/S ratio <2. Similarly, reactive lesions (n = 91) more commonly had an L/S ratio >2 (62 cases) compared to <2 (29 cases). Malignant lesions (n = 8) largely demonstrated an L/S ratio >2 (7 cases), with only 1 case showing <2. In contrast, metastatic lesions (n = 23) predominantly exhibited an L/S ratio <2 in 21 cases, with only 2 cases showing >2. These findings suggest that an L/S ratio <2 is more frequently associated with metastatic lesions, whereas an L/S ratio >2 is more common in reactive, tubercular, and primary malignant lesions.

Table 9: Distribution of ultrasonography echogenic hilum

Category	Present	Absent	Total
Reactive	81	10	91
Tubercular	8	70	78
Malignancy	1	7	8
Metastases	2	21	23

The presence of echogenic hilum was predominantly observed in reactive lymph nodes (81/91 cases). In contrast, the absence of a hilum was common in tubercular (70 cases), metastatic (21 cases), and malignant nodes (7 cases).

Loss of fatty hilum is a significant ultrasonographic indicator of pathological involvement, particularly in malignancy and tuberculosis. Preservation of the hilum strongly favours a benign/reactive aetiology.

Table 10: Distribution of border of nodes according to ultrasound

Category	Sharp	Unsharp	Total
Reactive	65	26	91
Tubercular	24	54	78
Malignancy	6	2	8
Metastases	18	5	23

The table shows the distribution of margin characteristics (sharp versus unsharp) among 200 cases across four pathological categories. Reactive lesions (n = 91) predominantly exhibited sharp margins in 65 cases (71.4%), while 26 cases (28.6%) were unsharp. In contrast, tubercular lesions (n = 78) more commonly demonstrated unsharp margins in 54 cases (69.2%), with only 24 cases (30.8%) showing sharp margins. Malignancies (n = 8) largely presented with sharp margins in 6 cases (75%) compared to 2 cases (25%) with unsharp margins. Similarly, metastatic lesions (n = 23) predominantly showed sharp margins in 18 cases (78.3%), while 5 cases (21.7%) had unsharp margins. Overall, sharp margins were more frequently observed in reactive, malignant, and metastatic lesions, whereas tubercular lesions were more commonly associated with unsharp margins.

Table 11: Distribution of lymph node echo texture according to USG

Category	Homogenous	Heterogeneous	Total
Reactive	73	18	91
Tubercular	12	66	78
Malignancy	3	5	8
Metastases	2	21	23

The table shows the distribution of internal echotexture patterns (homogeneous versus heterogeneous) among different pathological categories in 200 cases. Reactive lesions (n = 91) predominantly exhibited homogeneous echotexture in 73 cases, while 18 cases showed heterogeneous appearance. In contrast, tubercular lesions (n = 78) were mainly heterogeneous, with 66 cases demonstrating heterogeneous echotexture and only 12 cases appearing homogeneous. Malignancies (n = 8) more frequently showed heterogeneous echotexture (5 cases) compared to a homogeneous pattern (3 cases). Similarly, metastatic lesions (n = 23) predominantly exhibited heterogeneous echotexture in 21 cases, with only 2 cases showing homogeneous appearance. Overall, homogeneous echotexture was more commonly associated with reactive lesions, whereas heterogeneous echotexture was predominantly seen in tubercular, malignant, and metastatic lesions.

Table 12: Hilar vascularity on ultrasound diagnosis

Category	Present	Absent	Total
Reactive	77	14	91
Tubercular	8	70	78
Malignancy	1	7	8
Metastases	2	21	23

Hilar vascularity was present in the majority of reactive lymph nodes (77 cases) and was absent in most tubercular (70 cases), metastatic (21 cases), and malignant nodes (7 cases).

Preserved hilar vascularity is characteristic of benign nodes, whereas peripheral or absent vascularity raises suspicion for malignancy or advanced infective pathology.

Table 13: Capsular vascularity on ultrasound diagnosis

Category	Present	Absent	Total
Reactive	16	75	91
Tubercular	3	75	78
Malignancy	5	3	8
Metastases	14	9	23

Capsular/peripheral vascularity was more frequently seen in metastatic (14 cases) and malignant nodes (5 cases), whereas it was less common in reactive (16 cases) and tubercular nodes (3 cases).

Peripheral vascularity is a strong Doppler indicator of malignancy due to tumour-induced neoangiogenesis. Thus, Doppler evaluation significantly improves diagnostic accuracy.

5. Discussion

The evaluation of cervical lymphadenopathy relies heavily on distinguishing benign reactive or tubercular processes from malignant metastasis or lymphoma. In the Indian context, the high prevalence of tuberculosis often complicates this differentiation, as tubercular nodes can undergo caseous necrosis, losing their fatty hilum and mimicking malignancy.

Morphological Assessment: The S/L ratio, as described by Vassallo et al., proved crucial. Reactive nodes typically maintain an oval shape (S/L < 0.5), while malignant nodes adopt a spherical form (S/L > 0.5) due to disorganised tumour proliferation. The loss of the echogenic fatty hilum, while a strong indicator of pathology, was observed in both malignant infiltration and tuberculous caseous necrosis, necessitating additional parameters for accurate differentiation.

Vascular Patterns: Colour Doppler added a vital physiological dimension. Central/hilar flow (Pattern I) strongly correlated with benign reactive hyperplasia. Peripheral or capsular vascularity (Pattern II) was highly specific for metastatic malignancy, driven by tumor angiogenesis. Avascularity (Pattern IV) was predominantly seen in necrotic tubercular nodes or extensively necrotic squamous cell carcinoma metastases.

6. Conclusion

High-Resolution Ultrasonography combined with Colour Doppler is a highly sensitive, cost-effective, and non-invasive modality for the initial evaluation of cervical lymphadenopathy. By systematically assessing morphological features (shape, hilum, borders, necrosis) and vascular patterns, HRUS successfully differentiates between neoplastic and non-neoplastic nodes, serving as a reliable gatekeeper for selecting patients who require definitive cytological confirmation via FNAC

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