RESEARCH PAPER

Ultrasonographic Characterization of Neck Lesions: Cytopathological and Histopathological Correlation

Dr Pasam Naga Nikhila[1], Dr Shashikumar M R[2*], Dr Shashank B[3], Dr Pooja M[4], Chakravarthy P R[5]

[1]Post Graduate Scholar, Dept of Radiodiagnosis, Adichunchanagiri Institute of Medical Sciences, Adichunchanagiri University, B.G. Nagara – 571448, Karnataka, India.

[2]HOD, Dept of Radiodiagnosis, Adichunchanagiri Institute of Medical Sciences, Adichunchanagiri University, B.G. Nagara – 571448, Karnataka, India.*

[3]Associate Professor, Dept of Radiodiagnosis, Adichunchanagiri Institute of Medical Sciences, Adichunchanagiri University, B.G. Nagara – 571448, Karnataka, India.

[4]Assistant Professor, Dept of Radiodiagnosis, Adichunchanagiri Institute of Medical Sciences, Adichunchanagiri University, B.G. Nagara – 571448, Karnataka, India.

[5]Post Graduate Scholar, Dept of Radiodiagnosis, Adichunchanagiri Institute of Medical Sciences, Adichunchanagiri University, B.G. Nagara – 571448, Karnataka, India.

ABSTRACT

Background: Neck lesions include inflammatory, congenital, benign neoplastic, and malignant conditions, and early characterization guides management.

Objective: To evaluate the diagnostic performance of ultrasonography in neck lesions and correlate findings with cytopathology and histopathology.

Methods: This is a prospective, cross-sectional study that will be carried out in a tertiary-care teaching hospital between May 2024 and October 2025. A total of 53 patients with clinically suspected neck lesions were subjected to gray-scale and color Doppler ultrasonography with a 7.5-10 MHz linear transducer. Ultrasonographic benign-versus-malignant classification at the patient level was compared to FNAC, which is accessible to all patients. Secondary correlation was done by reviewing histopathology and surgical follow-up where available.

Results: Thyroid lesions were most common (28/53, 52.8%), followed by lymph-node lesions (12/53, 22.6%), salivary-gland lesions (8/53, 15.1%), and congenital cysts (5/53, 9.4%). Multiple lesions were present in 30/53 patients (56.6%), lesion size was <3 cm in 32/53 (60.4%), and adjacent structure involvement was seen in 21/53 (39.6%). Ultrasonography compared to FNAC had a sensitivity of 84.2, specificity of 85.3, positive predictive value of 76.2, negative predictive value of 90.6, overall accuracy of 84.9, and a high level of agreement (kappa = 0.68).

Conclusion: Ultrasonography demonstrated good patient-level diagnostic and high negative predictive value as a first-line, non-ionizing test of neck lesions. FNAC was still required in suspicious or discordant cases.

Keywords: Neck Lesions; Ultrasonography; Fine-Needle Aspiration Cytology; Histopathology; Thyroid Lesions; Cervical Lymph Nodes; Diagnostic Accuracy.

How to cite this article: Pasam Naga Nikhila, Shashikumar MR, Shashank B, Pooja M, Chakravarthy PR. Ultrasonographic Characterization of Neck Lesions: Cytopathological and Histopathological Correlation. Int J Drug Deliv Technol. 2026;16(57s): 147-152. DOI: 10.25258/ijddt.16.57s.19

INTRODUCTION

Neck lesions represent a frequent clinical manifestation and include a heterogeneous group of pathological entities that include inflammatory and congenital diseases, benign tumors, primary malignancies, and metastatic disease. Early characterization is crucial since the treatment of reactive lymphadenopathy, congenital cysts, thyroid nodules, salivary-gland lesions, and metastatic nodes varies significantly. [1,2]

The ultrasonography is now the imaging modality of choice in the first line of imaging in superficial neck pathology due to its non-invasive nature, wide availability, low cost, radiation free and real time dynamic evaluation. It is especially useful in the evaluation of thyroid lesions, cervical lymph nodes, and major salivary glands. The lesion characterization has also been enhanced by technical

advances in high-resolution sonography and Doppler imaging. [2-4]

There are some sonographic characteristics that are known to aid in stratifying the risk of malignancy. Hypoechogenicity, irregular margins, microcalcifications, and taller-than-wide shape are suspicious findings in thyroid nodules. Doppler imaging of malignant involvement in cervical lymph nodes is indicated by round configuration, loss of echogenic hilum, heterogeneous internal architecture, necrosis, calcification, peripheral or mixed vascularity. However, ultrasound is still operator-dependent and structured training and experience are needed to achieve consistent performance. [5-8]

Tissue diagnosis remains an important complementary role in the evaluation of neck lesions. Fine-needle aspiration cytology is less invasive, fast and clinically applicable in distinguishing between benign and malignant lesions, whereas ultrasound guidance may enhance the accuracy of sampling in non-palpable, heterogeneous, or anatomically challenging lesions. Further pathological confirmation is by histopathological examination, where possible, by biopsy or surgery. [9-11]

Although the usefulness of ultrasonography in thyroid disease and cervical lymphadenopathy is established, there is a paucity of prospective institutional data assessing a mixed spectrum of neck lesions in routine tertiary-care practice. The current research was thus conducted to evaluate the diagnostic accuracy of ultrasonography in neck lesions and to compare the sonographic results with cytopathology and histopathology.

MATERIALS AND METHODS

Study design and reporting approach

This was a prospective, hospital-based cross-sectional study conducted in the Department of Radiodiagnosis, Adichunchanagiri Institute of Medical Sciences, B.G. Nagara, Karnataka, India, over an 18-month period from May 2024 to October 2025.

To improve traceability, all numeric analyses reported in the present manuscript were rebuilt directly from the archived patient-level master chart rather than from summary graphics. This ensured that every reported table could be checked against the underlying analytic record retained in the thesis appendix.

Participants and eligibility

The population of the study included patients who were referred with clinically suspected neck pathology. A total of 53 eligible participants were used. Any age and sex patient were eligible. Exclusion criteria included lesions of vascular origin, lesions of trauma or fracture, lesions that extended into the neck along the lung apices or chest wall, lesions of the mandible, and poor pathological follow-up or correlation.

Index test

All participants underwent ultrasonographic examination in the supine position with mild neck hyperextension. The ultrasound machine used was a Voluson E6 with a high-frequency linear transducer of 7.5-10 MHz to perform gray-scale ultrasonography and color Doppler imaging. Longitudinal and transverse real-time scans were acquired. Lesions were evaluated based on anatomical location, size, multiplicity, echogenicity or composition, margins, calcification pattern when applicable, halo features when applicable, vascularity, ductal dilatation in salivary lesions when applicable, nodal matting when applicable, and involvement of adjacent structures. The unit of analysis was the patient, not the individual lesion.

Reference standards and analytic sets

The archived study master chart included one patient-level ultrasonographic impression of benign or malignant, and a corresponding benign or malignant FNAC outcome of each of the 53 participants included. Since paired FNAC data were available throughout the entire cohort, FNAC was the main uniform comparator of the prespecified patient-level diagnostic accuracy analysis. A final diagnosis column was also maintained in the master chart that indicated downstream pathological or clinical adjudication following FNAC and follow-up. The underlying confirmation pathway was however not consistent across all participants and the archived records lacked a complete patient level denominator of excision-based histopathology. Final diagnoses were thus descriptively employed to summarize the pathological spectrum and to review discordant cases, but not as the formal primary reference standard. There were no nondiagnostic or indeterminate FNAC categories in the final analytic dataset since all the patients included had a dichotomized benign or malignant FNAC outcome in the study master chart. In the case of participants with multiple lesions, the original archived data contained a single overall patient-level ultrasonographic impression and a single paired FNAC outcome; lesion-level adjudication rules were not maintained separately, and the current analysis used the original patient-level classification instead of trying to reconstruct lesion-level results retrospectively.

Blinding and quality safeguards

The archived study records failed to maintain clear records of whether sonologists were blinded to cytology or cytopathologists blinded to ultrasound results. Status of blinding should thus be regarded as unverified and is recognized as a limitation. To provide an internal quality protection to the existing manuscript, all the confusion-matrix counts, percentages, and descriptive diagnosis frequencies were re-calculated using the patient-level master chart prior to writing the revised article.

Statistical analysis

Descriptive statistics were summarized in terms of counts and percentages. The 2 x 2 contingency table was used to calculate sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy. The Wilson method was used to determine ninety-five percent confidence intervals (CIs). Cohen kappa was used to determine agreement between ultrasonography and FNAC and a nonparametric bootstrap with 10,000

resamples was employed to estimate the 95% CI of kappa.

Ethical considerations

Institutional ethics committee approval was obtained before commencement of the study, and written informed consent was taken from all participants or their legal guardians. The ethics approval number was EC/NEW/INST/2023/KA/0382.

RESULTS

Study flow and analytic sets

The total number of eligible participants who entered the study was 53 and all 53 were subjected to ultrasonography with paired benign or malignant FNAC findings in the archived master chart. These 53 respondents thus formed the entire primary analysis set. The final-diagnosis column of the master chart was also checked to summarize the observed pathological spectrum and to analyze discordant cases.

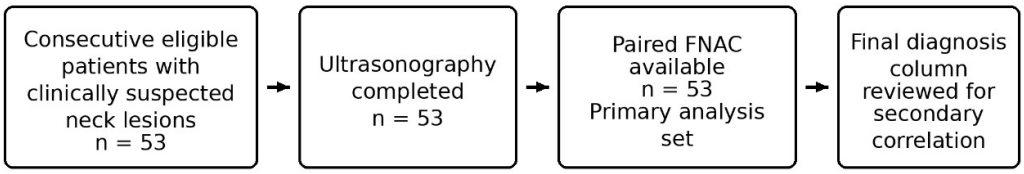

Figure 1. Study flow and analytic sets.

Baseline characteristics and lesion spectrum

The largest age stratum was 51-60 years (12/53, 22.6%). Females constituted 30/53 patients (56.6%), while males accounted for 23/53 (43.4%). There were 30/53 patients with multiple lesions (56.6%), lesion size less than 3 cm (32/53, 60.4%), and adjacent structure involvement (21/53, 39.6%) (Table 1).

The most common pathology was thyroid lesions (28/53, 52.8%), then lymph-node lesions (12/53, 22.6%), salivary-gland lesions (8/53, 15.1%), and congenital cysts (5/53, 9.4%).

Primary FNAC-based diagnostic performance

To conduct the main cytopathological comparison, ultrasonography classified 21 participants as malignant and 32 as benign. Ultrasonography had 16 true positives, 29 true negatives, 5 false positives, and 3 false negatives compared to FNAC (Table 3).

Based on this comparison, ultrasonography showed a sensitivity of 84.2% (95% CI: 62.4%-94.5%), specificity of 85.3% (69.9%-93.6%), PPV of 76.2% (54.9%-89.4%), NPV of 90.6% (75.8%-96.8%), and overall accuracy of 84.9% (72.9%-92.1%). The ultrasonography and FNAC had a high level of agreement with a Cohen kappa of 0.68 (95% bootstrap CI: 0.46-0.87) (Table 4).

Secondary final-diagnosis review

The final diagnosis column of the master chart revealed that papillary thyroid carcinoma was the most common diagnosis (13/53, 24.5%), then multinodular goitre (11/53, 20.8%). Other frequent diagnoses were pleomorphic adenoma (5/53, 9.4%), thyroglossal cyst (4/53, 7.5%), and Hashimoto thyroiditis (3/53, 5.7%) (Table 5).

The discordant-case review was an added context to the main FNAC-based analysis. Three of the five FNAC-benign and ultrasonography-malignant cases were eventually listed as papillary thyroid carcinoma in the final diagnosis column, and three of the FNAC-malignant and ultrasonography-benign cases were eventually listed as benign conditions, namely multinodular goitre, nonspecific lymphadenitis, and pleomorphic adenoma (Table 6). This trend indicates that downstream adjudication occasionally deviated off the standard FNAC comparator and justifies the view that the primary analysis is a pragmatic FNAC-based performance evaluation and not a final-truth analysis.

Table 1. Baseline demographic and lesion characteristics (n = 53).

Characteristic or category	n	%
Age group		
1-10 years	4	7.5
11-20 years	4	7.5
21-30 years	6	11.3
31-40 years	9	17.0
41-50 years	9	17.0
51-60 years	12	22.6

>=61 years	9	17.0
Sex		
Male	23	43.4
Female	30	56.6
Number of lesions		
Solitary	23	43.4
Multiple	30	56.6
Largest recorded lesion size		
<3 cm	32	60.4
3-5 cm	13	24.5
>5 cm	8	15.1
Adjacent structure involvement		
Present	21	39.6
Absent	32	60.4

Table 2. Anatomical distribution of neck lesions (n = 53).

Anatomical site	n	%
Thyroid lesions	28	52.8
Lymph-node lesions	12	22.6
Salivary-gland lesions	8	15.1
Congenital cysts	5	9.4

Table 3. Patient-level cross-tabulation of ultrasonography versus FNAC.

Ultrasonography	FNAC malignant	FNAC benign	Total
Malignant	16	5	21
Benign	3	29	32
Total	19	34	53

Table 4. Diagnostic performance of ultrasonography against FNAC.

Metric	Estimate	95% CI
Sensitivity	84.2%	62.4%-94.5%
Specificity	85.3%	69.9%-93.6%
Positive predictive value	76.2%	54.9%-89.4%
Negative predictive value	90.6%	75.8%-96.8%
Overall accuracy	84.9%	72.9%-92.1%
Cohen's kappa	0.68	0.46-0.87 (bootstrap)

Table 5. Final recorded diagnostic spectrum from the patient-level master chart (n = 53).

Final diagnosis	n	%
Papillary thyroid carcinoma	13	24.5
Multinodular goitre	11	20.8
Pleomorphic adenoma	5	9.4
Thyroglossal cyst	4	7.5
Hashimoto's thyroiditis	3	5.7
Metastatic lymph nodes	2	3.8
Tubercular lymphadenitis	2	3.8
Bacterial acute lymphadenitis	2	3.8
Other single diagnoses combined	11	20.8

Table 6. Review of ultrasonography-FNAC discordant cases.

Case	Lesion group	USG	FNAC	Final recorded diagnosis
4	Thyroid	Benign	Malignant	Multinodular goitre
5	Salivary gland	Malignant	Benign	Acute parotitis
8	Lymph node	Benign	Malignant	Lymphadenitis
9	Thyroid	Malignant	Benign	Papillary thyroid carcinoma
20	Congenital cyst	Malignant	Benign	Infected branchial cleft cyst

26	Salivary gland	Benign	Malignant	Pleomorphic adenoma
33	Thyroid	Malignant	Benign	Papillary thyroid carcinoma
53	Thyroid	Malignant	Benign	Papillary thyroid carcinoma

DISCUSSION

This proposed tertiary-care study was able to show that ultrasonography has a good patient-level diagnostic performance on the initial examination of neck lesions with both sensitivity and specificity of the mid-80s range with a high negative predictive value. These results confirm its use in the clinic as a convenient first-line rule-out method in the lesions that can be suspected of being benign yet remain useful in identifying most of the malignant lesions in a mixed group, as has been previously reported in the evaluation of ultrasound in head and neck masses [1318].

The population under study was largely made up of thyroid lesions, with a little more than half of the cases. The distribution should be determined in a tertiary-care imaging environment, where thyroid abnormalities are prevalent, can be easily subjected to ultrasound, and often of high priority in terms of radiological investigation [2,12]. Nevertheless, such dominance probably affected the overall diagnostic indices and must be taken into account when comparing the results with organ-specific ones [5–7].

Discordant analysis is a valuable source of clinical information. A few lesions which had been benign by FNAC and malignant by ultrasound were later on found to be papillary thyroid carcinoma, and some lesions which had been malignant by FNAC and benign by ultrasound were found to be non-malignant. This underscores the fact that FNAC was used as a standard reference across the cohort, but was not necessarily the ultimate diagnostic endpoint [9,10]. Although the foundation of formal accuracy calculations was cytopathology, further histopathological results and follow-up data (where available) were used to form final diagnoses. These differences can be explained by clinical plausibility as inflammatory salivary conditions and infected branchial cleft cysts can mimic malignancy on ultrasound, whereas false-negative FNAC outcomes can be caused by sampling issues, specifically in small or multifocal lesions [9,10].

The level of diagnostic performance in this study, compared to the existing literature, is within the range of diagnostic performance reported concerning ultrasound to assess mixed neck masses [1318]. Even though greater accuracy has been documented in more specific thyroid or lymph node trials, the larger case mix here is more of a reflection of real-world tertiary-care practice. Likewise, the level of thyroid pathology is similar to other institutional reports, but restricts the direct comparison with studies that are dedicated to the individual subgroups of the anatomy [1216].

The strengths of the research are that they are prospective, have full paired ultrasonography and FNAC data in all subjects and have meticulously reconstructed analyses using patient-level data. Inclusion of a detailed discordant-case review also adds to the level of transparency. Nevertheless, small, single-center sample size and the heterogeneous cohort are some of the limitations that limit the power of subgroup analyses. The dependence of ultrasonography on the operator and the inability to evaluate the interobserver variability are other limitations [8], as well as the lack of reported blinding. Notably, histopathological confirmation was not uniform in all of the cases, which implies that the study represents mostly the FNAC-based diagnostic accuracy complemented by the available pathology and follow-up data.

In general, the results support the usefulness of ultrasonography as a convenient and effective first-line imaging tool in cases of neck lesions, as well as the need to include tissue confirmation in the cases of suspicion or inconclusive outcomes [2,9,10]. To reinforce the evidence and make it more applicable to the high-impact clinical settings, the evidence would require future larger, multicenter studies with more detailed subgroup analyses, standardized blinding protocols, and detailed histopathological correlations.

CONCLUSION

The initial characterization of neck lesions at the patient level in this prospective tertiary-care cohort showed good performance with ultrasonography. Its primary clinical utility was as a first-line imaging test that was easily accessible, non-ionizing, and had a high negative predictive value. FNAC was the sole comparator in the entire cohort, and thus it formed the backbone of the main diagnostic accuracy analysis, with final diagnoses and histopathological correlations available to put discordant cases into perspective. There are still suspicious or radiologic-pathologic discordant lesions that need tissue confirmation.

DECLARATIONS

Ethics approval and consent to participate:
The study was approved by the Institutional Ethics Committee of Adichunchanagiri Institute of Medical Sciences (EC/NEW/INST/2023/KA/0382). Written informed consent was obtained from all participants or their legal guardians.

Consent for publication: Not applicable.

Funding: None.

Conflicts of interest: The authors declare no conflicts of interest.

Data availability: De-identified study data may be made available by the corresponding author on reasonable request, subject to institutional approval.

REFERENCES

1. Chowdhury R, Turkdogan S, Alsayegh R, Almhanedi H, Al Majid D, Le Blanc G, et al. Comprehensive diagnostic approach to head and neck masses. J Otorhinolaryngol Hear Balance Med. 2024;5(2):17.
2. Feier J, Self Q, Karabachev A, Brundage W, Sajisevi

M. Assessing the role of ultrasound for the evaluation of adult neck masses. Laryngoscope Investig Otolaryngol. 2023;8(1):135-139.
3. Schneider U, Grass I, Laudien M, Quetz J, Graefe H, Wollenberg B, et al. Comparison of clinical examination and various imaging modalities in the diagnosis of head and neck cancer. Int Arch Otorhinolaryngol. 2021;25(2):e179-e184.
4. McQueen AS, Bhatia KSS. Thyroid nodule ultrasound: technical advances and future horizons. Insights Imaging. 2015;6(2):173-188.
5. Rago T, Vitti P. Risk stratification of thyroid nodules: from ultrasound features to TIRADS. Cancers (Basel). 2022;14(3):717.
6. Ying M, Bhatia KSS, Lee YP, Yuen HY, Ahuja AT. Review of ultrasonography of malignant neck nodes: greyscale, Doppler, contrast enhancement and elastography. Cancer Imaging. 2014;13(4):658-669.
7. Prativadi R, Dahiya N, Kamaya A, Bhatt S. Ultrasound characteristics of benign versus malignant cervical lymph nodes. Semin Ultrasound CT MR. 2017;38(5):506-515.
8. Warm JJ, Melchiors J, Kristensen TT, Aabenhus K, Charabi BW, Eberhard K, et al. Head and neck ultrasound training improves the diagnostic performance of otolaryngology residents. Laryngoscope Investig Otolaryngol. 2024;9(1):e1201.
9. Poorey VK, Tyagi A. Accuracy of fine needle aspiration cytology in head and neck masses. Indian J Otolaryngol Head Neck Surg. 2014;66(2):182-186.
10. Rammeh S, Romdhane E, Sassi A, Belhajkacem L, Blel A, Ksentini M, et al. Accuracy of fine-needle aspiration cytology of head and neck masses. Diagn Cytopathol. 2019;47(5):394-399.
11. Tarigan TJE, Anwar BS, Sinto R, Wisnu W. Diagnostic accuracy of palpation versus ultrasound-guided fine needle aspiration biopsy for diagnosis of malignancy in thyroid nodules: a systematic review and meta-analysis. BMC Endocr Disord. 2022;22(1):181.
12. Naaz F, Choudhry U, Qaiyum H. Role of ultrasonography in the diagnosis of neck mass. J Med Allied Sci. 2018;8(2):66.
13. Sohi N, Gupta D, Ohri P, Sharma RK, Kaur N. Role of high resolution ultrasonography and Doppler in the evaluation of neck masses. Int J Life Sci Biotechnol Pharma Res. 2023;12(2):1693-1697.
14. Jain S. Comparative study of FNAC, USG, US-FNAC, and HPE in diagnosis of neck swellings. UPJOHNS. 2021;9(2):15-21.
15. Kumar ER, Chithra CP, Ramakrishnan VR. A study of clinical, imaging, and pathological correlation of neck masses. Int J Acad Med Pharm. 2025;7(1):129-133.
16. Jadhav GS, Kombade BH, Komwad AL. Role of ultrasound in evaluation of neck masses. J Sci Soc. 2025;52(3):223-227.
17. Jaiswal P, Sharma P. Value of ultrasound in evaluation of cervical lymphadenopathy: correlation with FNAC/histopathology. J Soc Surg Nepal. 2016;19(1):13-20.
18. Bhardwaj D, Rakareddi M, Barthunia B, Mishra R, Singla M, Chavda S. Efficacy of ultrasonography in head and neck swellings and comparison with histopathological and clinical diagnosis. IOSR J Dent Med Sci. 2017;16(3):104-106.