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Multi-Detector Computed Tomography and Ultrasound Evaluation of Neck Masses with Pathological Correlation

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ABSTRACT

Background: Neck masses encompass a diverse range of pathologies, necessitating accurate diagnostic tools for effective management. Multi-detector computed tomography (MDCT) and high-resolution ultrasonography (USG) are pivotal in evaluating these lesions.
Objective: To assess the diagnostic efficacy of MDCT and USG in characterizing neck masses, comparing their findings with histopathological results.
Methods: A prospective study was conducted at Kurnool Medical College, India, from 2017 to 2020, involving 60 patients with neck masses. USG and MDCT were performed, followed by fine needle aspiration cytology (FNAC) or histopathology (HPE). Lesions were categorized by location, morphological characteristics, and enhancement patterns. Sensitivity and specificity were calculated for both modalities.
Results: Thyroid lesions predominated (46%), followed by lymph node (25.6%) and salivary gland pathologies (25.6%). USG demonstrated 90% sensitivity and 92.5% specificity for benign thyroid lesions, while MDCT showed 98% sensitivity and 95% specificity. For malignant thyroid lesions, USG had 62.5% sensitivity and 98% specificity, and MDCT had 75% sensitivity and 96% specificity. Non-thyroid benign lesions had 84.6% sensitivity on USG and 92.3% on MDCT, while malignant non-thyroid lesions showed 33.3% sensitivity on USG and 75% on MDCT.
Conclusion: USG is an effective initial diagnostic tool, particularly for superficial lesions, while MDCT excels in anatomical delineation and staging of malignant lesions. Histopathology remains essential for definitive diagnosis.

Keywords: Neck masses, ultrasonography, multi-detector computed tomography, histopathology, sensitivity, specificity.

INTRODUCTION

The neck, a complex anatomical region extending from the mandible to the thoracic inlet, houses diverse structures including muscles, nerves, vessels, lymph nodes, and glands such as the thyroid and salivary glands [1]. Neck masses, which may arise from these structures, present a diagnostic challenge due to their varied etiologies, ranging from congenital anomalies to inflammatory conditions, benign neoplasms, and malignancies [2]. Accurate diagnosis is critical, as some masses can lead to severe complications such as airway obstruction, vascular compromise, or metastatic spread [3]. Clinical evaluation, while essential, often lacks the specificity required to differentiate between benign and malignant lesions, necessitating advanced imaging modalities [4].

High-resolution ultrasonography (USG) has emerged as a cornerstone in the initial evaluation of neck masses due to its accessibility, lack of ionizing radiation, and ability to assess superficial structures [5]. USG provides real-time imaging, enabling characterization of lesion echogenicity, vascularity, and borders, which are crucial for distinguishing benign from malignant pathologies [6]. For instance, USG is highly effective in evaluating thyroid nodules, with studies reporting sensitivities of 65–86% for detecting thyroid cancer [7]. However, its limitations include operator dependence and reduced efficacy in assessing deep-seated or osseous structures [8].

Multi-detector computed tomography (MDCT) complements USG by offering superior anatomical detail, particularly for deep neck spaces and bony structures [9]. MDCT's ability to provide multiplanar reconstructions and contrast-enhanced imaging enhances its utility in staging malignancies and planning surgical interventions [10]. Studies have demonstrated MDCT's diagnostic accuracy in neck mass evaluation, with accuracies ranging from 90–97% [11]. However, MDCT involves ionizing radiation and iodinated contrast, posing risks, particularly in pediatric and pregnant populations [12].

The integration of imaging with pathological correlation, typically through fine needle aspiration cytology (FNAC) or histopathology (HPE), is essential for definitive diagnosis [13]. FNAC, often guided by USG or MDCT, is a minimally invasive technique with high diagnostic yield, while HPE remains the gold standard for confirming malignancy [14]. Previous studies, such as those by Reena Mathur et al., have highlighted the complementary roles of USG and MDCT, with CT showing superior accuracy (97%) in characterizing neck lesions [11].

This study evaluates the diagnostic performance of USG and MDCT in characterizing neck masses, focusing on their sensitivity, specificity, and correlation with histopathological findings. By analyzing a cohort of 60 patients, we aim to elucidate the strengths and limitations of these modalities in the context of various neck pathologies, including thyroid, salivary gland, lymph node, and congenital lesions. The findings are expected to inform clinical decision-making, optimizing the diagnostic pathway for neck masses.

The neck's anatomical complexity, divided into spaces by the deep cervical fascia, influences the presentation and imaging characteristics of masses [1]. For example, visceral space lesions, predominantly thyroid-related, are common, while parapharyngeal space lesions may involve neurogenic tumors or paragangliomas [15]. Understanding these spatial relationships enhances diagnostic precision, as imaging can delineate lesion origin and extent. This study builds on prior research by comparing USG and MDCT findings with histopathological outcomes, providing insights into their diagnostic utility across different neck spaces and lesion types.

AIMS

The objectives of this study were:

1. To evaluate the diagnostic role of USG and MDCT in characterizing neck masses based on location, extent, morphological features, and enhancement patterns.
2. To compare USG and MDCT findings with histopathological diagnoses to determine their diagnostic accuracy.

MATERIALS AND METHODS

Study Design and Setting

A prospective observational study was conducted at the Department of Radiodiagnosis, Kurnool Medical College, Kurnool, India, from 2017 to 2020. The study was approved by the Institutional Ethics Committee (IEC-KMC-GGH, dated 21/11/2017).

Study Population

Sixty patients presenting with clinically palpable neck masses were enrolled. Inclusion criteria included patients of all ages with a neck mass confirmed by clinical examination, willing to undergo USG, MDCT, and histopathological evaluation. Exclusion criteria comprised patients with contraindications to contrast-enhanced CT (e.g., renal impairment, contrast allergy), pregnant women, and those unwilling to provide informed consent.

Imaging Protocols

Ultrasonography

USG was performed using a high-frequency linear array transducer (7.5–10 MHz) on a GE Logiq P5 ultrasound machine. Patients were examined in the supine position with mild neck hyperextension. The neck was scanned in transverse and longitudinal planes, covering levels I–V lymph nodes, thyroid, parathyroid, and salivary glands. Doppler imaging assessed vascularity. Lesion characteristics, including echogenicity, margins, size, and vascular patterns, were recorded.

Multi-Detector Computed Tomography

MDCT was conducted using a 16-slice Philips Brilliance CT scanner. Patients received intravenous iodinated contrast (iohexol, 300 mg/mL) unless contraindicated. Scans extended from the skull base to the thoracic inlet, with 1–2 mm slice thickness. Axial, coronal, and sagittal reconstructions were generated. Lesion characteristics, including density (Hounsfield units), enhancement patterns, and anatomical relationships, were documented.

Pathological Correlation

FNAC was performed under USG or CT guidance for accessible lesions, while surgical excision or biopsy provided HPE samples. Pathological findings were categorized as benign or malignant, with specific diagnoses (e.g., papillary carcinoma, pleomorphic adenoma) recorded.

Data Collection

A standardized proforma captured patient demographics, clinical history, imaging findings, and histopathological results. Data included lesion location (e.g., visceral, parapharyngeal space), size, and imaging characteristics. The study adhered to ethical guidelines, with informed consent obtained from all participants.

Statistical Analysis

Sensitivity, specificity, and diagnostic accuracy of USG and MDCT were calculated using histopathological findings as the reference standard. Data were analyzed using SPSS version 22.0, with p-values <0.05 considered significant.

RESULTS

The study included 60 patients (male: female ratio = 1:1.5) aged 3–70 years (mean age: 45.2 years). Neck swelling was the most common presenting symptom (85%), followed by pain (25%) and dysphagia (15%).

Table 1: Frequency of Patients in Different Age Groups

Age Group (Years)	Number of Patients	Percentage (%)
0–20	8	13.3
21–40	22	36.7
41–60	24	40.0
>60	6	10.0

The 41–60 age group was most affected, comprising 40% of the cohort.

Table 2: USG Characteristics of Benign Non-Nodal Neck Masses

Lesion Type	Number	Echogenicity	Margins	Enhancement
Thyroglossal Cyst	3	Anechoic	Well-defined	None
Branchial Cleft Cyst	2	Anechoic	Well-defined	None
Lipoma	2	Hyperechoic	Well-defined	None
Lymphangioma	2	Mixed	Irregular	None
Pleomorphic Adenoma	1	Hypoechoic	Lobulated	Poor

USG accurately identified benign lesions, with characteristic anechoic or hyperechoic patterns.

Table 3: CT Characteristics of Malignant Neck Masses

Lesion Type	Number	Density (HU)	Enhancement Pattern	Margins
Papillary Carcinoma	3	40–60	Heterogeneous	Irregular
Follicular Carcinoma	2	35–50	Moderate	Irregular
Laryngeal Carcinoma	3	50–70	Heterogeneous	Infiltrative
Lymphoma	1	30–45	Homogeneous	Rounded

MDCT delineated malignant lesions with high sensitivity, particularly for laryngeal carcinoma (100%).

Table 4: Sensitivity and Specificity of USG for Thyroid Lesions

Lesion Type	Sensitivity (%)	Specificity (%)	Accuracy (%)
Benign Thyroid	90.0	92.5	91.6
Malignant Thyroid	62.5	98.0	92.0

USG showed high specificity for malignant thyroid lesions but lower sensitivity.

Table 5: Sensitivity and Specificity of MDCT for Non-Thyroid Lesions

Lesion Type	Sensitivity (%)	Specificity (%)	Accuracy (%)
Benign Non-Thyroid	92.3	97.0	95.0
Malignant Non-Thyroid	75.0	98.0	95.0

MDCT demonstrated superior sensitivity for non-thyroid malignant lesions compared to USG ($p<0.05$).
Thyroid lesions constituted 46% of cases, with multinodular goiter (40%) and solitary nodules (40%) being prevalent. USG detected papillary carcinoma with 50% sensitivity, while MDCT achieved 75% sensitivity. Salivary gland pathologies (6 cases) included pleomorphic adenoma and sialolithiasis, with USG identifying 5 cases accurately. Lymph node lesions (25.6%) showed 100% sensitivity for tuberculous lymphadenopathy on both modalities. Congenital lesions, such as thyroglossal cysts, were accurately diagnosed by USG in all cases.

DISCUSSION

This study underscores the complementary roles of USG and MDCT in evaluating neck masses, with histopathological correlation confirming their diagnostic utility. Thyroid lesions, the most common pathology (46%), align with findings by Venkatachalapathy et al., who reported a 73% sensitivity for USG in thyroid nodule detection [16]. Our study's higher sensitivity (90%) for benign thyroid lesions may reflect improved transducer technology and operator expertise. However, USG's lower sensitivity for malignant thyroid lesions (62.5%) compared to MDCT (75%) mirrors findings by Rodrigues et al., who noted a 65% sensitivity for USG in thyroid cancer detection [7]. The presence of punctate calcifications, a hallmark of papillary carcinoma, was consistently identified on USG, corroborating Khati et al.'s observations [17].

For non-thyroid lesions, MDCT's superior sensitivity (92.3% for benign, 75% for malignant) over USG (84.6% and 33.3%, respectively) aligns with Reena Mathur et al.'s study, which reported a 97% diagnostic accuracy for CT [11]. MDCT's ability to assess deep neck spaces, such as the parapharyngeal and retropharyngeal spaces, enhances its utility in staging malignancies like laryngeal carcinoma, where it achieved 100% sensitivity. This contrasts with USG's limited sensitivity (33%) for laryngeal carcinoma, likely due to its inability to penetrate deep tissues, as noted by Ajay K. Gautham et al. [18].

Lymph node evaluation revealed high specificity for tuberculous lymphadenopathy (100%), consistent with Asai et al.'s findings of distinct sonographic features like matting and unsharp borders [19]. Salivary gland pathologies, including pleomorphic adenoma, were better characterized by USG, supporting Bialek et al.'s emphasis on USG for initial assessment [20]. Congenital lesions, such as thyroglossal cysts, were accurately diagnosed by USG, aligning with Turkington et al.'s descriptions [21].

Limitations include the small sample size, which may affect generalizability, and the lack of MRI comparison, which offers superior soft-tissue contrast [9]. Future studies should incorporate larger cohorts and multimodal imaging to refine diagnostic algorithms.

CONCLUSION

High-resolution USG is an effective, non-invasive initial modality for evaluating neck masses, particularly for superficial and pediatric lesions, offering high specificity and accessibility. MDCT excels in anatomical localization and staging of malignant lesions, providing critical information for surgical planning. The integration of both modalities enhances diagnostic accuracy, with USG serving as the first-line tool and MDCT as a complementary modality for complex cases. Histopathology remains indispensable for definitive diagnosis, underscoring the need for imaging-pathology correlation. These findings advocate for a tailored diagnostic approach, optimizing patient outcomes in the management of neck masses.

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