

A COMPARATIVE STUDY OF CT AND MRI FINDINGS FOR EVALUATING NECK MASSES
IN ADULTS

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Abstract

Background: Neck masses in the adults represent the prevalent clinical issue that has broad spectrum of the etiologies, such as inflammatory, congenital and the malignant. The first and most important things to do is to detect benign and malign lesions early and accurately to treat them properly. Other imaging modalities like MRI and CT are important.

Objective: To compare the effectiveness of CT and MRI in evaluating the morphological features, enhancement patterns, and tissue characteristics of neck masses in adult patients.

Methodology: A cross-sectional study was done on 73 patients, they examined the characteristics of CT and MRI and compared them with the final diagnoses using statistical tests.

Results: CT and MRI imaging features showed a strong correlation with the final diagnosis ($p < 0.001$). CT effectively demonstrated structural details such as morphology and calcifications, while MRI provided superior soft tissue characterization and lesion differentiation. The combined use of both modalities improved diagnostic accuracy and confidence. Overall, their complementary role ensures a more reliable evaluation of neck masses.

Conclusion: CT and MRI both play essential and complementary roles in evaluating adult neck masses. CT is superior for assessing morphology, calcifications, and structural details, while MRI offers better soft-tissue characterization and differentiation between benign

and malignant lesions. Combining both modalities improves diagnostic accuracy and supports earlier detection. This integrated approach also enhances clinical decision-making and reduces the risk of misdiagnosis.

INTRODUCTION

Neck masses in adults represent abnormal swellings arising from diverse etiologies, including lymphatic, salivary, thyroid, congenital, inflammatory, and neoplastic origins. Their clinical presentation ranges from benign, self-limiting conditions to potentially life-threatening malignancies such as squamous cell carcinoma, lymphoma, or metastatic lymphadenopathy. Often, a neck mass may be the initial or sole manifestation of an underlying serious disease, making early and accurate diagnosis critical. Prompt identification facilitates appropriate management, thereby improving patient outcomes and reducing morbidity and mortality. Advanced imaging modalities, particularly Computed Tomography (CT) and Magnetic Resonance Imaging (MRI), play a central role by providing detailed anatomical and pathological information necessary for accurate evaluation and treatment planning (1).

Neck masses are a common clinical finding worldwide and pose a diagnostic challenge due to their varied etiologies. Epidemiological data indicate a prevalence of approximately 14.1% in the general population, encompassing a spectrum from benign inflammatory conditions to malignant neoplasms. The likelihood of malignancy increases with age, necessitating careful evaluation in adult patients. Clinical examination alone is often insufficient to determine the origin, extent, or internal characteristics of these masses. Therefore, imaging modalities such as CT and MRI are essential, offering high-resolution cross-sectional visualization. CT is particularly useful for detecting calcifications

and bone involvement, while MRI excels in soft tissue contrast and multiplanar imaging, enhancing diagnostic accuracy and clinical decision-making (2).

Regional studies highlight the variability in etiology and prevalence of neck masses. In India, approximately 42% of cases are attributed to inflammatory or infective causes, while thyroid disorders account for about 35%. Tubercular lymphadenitis remains a significant contributor due to endemicity. Similarly, studies from Bangladesh report a predominance of inflammatory masses (70.1%), with neoplastic lesions comprising a smaller proportion. Conversely, in Australia and Zambia, a higher prevalence of malignant masses, particularly metastatic lymphadenopathy, has been observed, especially in older populations. These regional differences underscore the importance of context-specific diagnostic approaches and reinforce the role of imaging in differentiating between inflammatory and neoplastic conditions, guiding effective management strategies (3–6). Clinically, adult neck masses may present with similar features, necessitating careful assessment of associated symptoms to guide differential diagnosis. Common presentations include visible or palpable swelling, with characteristics such as duration, growth pattern, and associated pain providing diagnostic clues. Painful and tender masses are typically associated with inflammatory conditions, whereas painless, persistent masses may suggest malignancy. Additional symptoms such as dysphagia, hoarseness, weight loss, fever, and night sweats may indicate deeper involvement or systemic disease. Comprehensive history taking and physical examination remain fundamental, helping clinicians assess size, consistency, and mobility of the mass and determine the need for further diagnostic investigations, including imaging and biopsy (7–8).

The pathophysiology of neck masses often involves immune and inflammatory responses within cervical lymphatic structures. Reactive lymphadenopathy, a common

mechanism, occurs due to antigenic stimulation from infections or inflammatory conditions, leading to lymph node enlargement through cellular proliferation and vascular changes. These nodes are typically soft, mobile, and tender. In chronic or severe infections, abscess formation may occur. Imaging plays a vital role in assessing nodal architecture and distinguishing reactive changes from malignant alterations, which often disrupt normal structure. Ultrasound has emerged as an important first-line modality, offering a non-invasive, cost-effective method for evaluating nodal characteristics and guiding further diagnostic steps (9–10).

A systematic, multimodal approach is essential for accurate diagnosis and management of adult neck masses. This includes clinical evaluation, imaging, and cytological or histopathological assessment. Ultrasound, fine-needle aspiration cytology (FNAC), and, when necessary, histopathology provide complementary diagnostic information. CT and MRI further aid in defining lesion extent and anatomical relationships, particularly for surgical planning. Advances in treatment, especially for malignant cases, now include multimodal strategies combining surgery, radiotherapy, chemotherapy, and emerging therapies such as immunotherapy and targeted treatments. These approaches are guided by tumor stage, molecular markers, and patient factors. Overall, integrating clinical findings with advanced imaging enhances diagnostic precision and supports effective, individualized patient management (11–12).

Literature Review

Fujima et al. (2019) investigated advanced MRI texture and histogram analysis in 70 patients with histopathologically confirmed head and neck malignancies. Using fat-suppressed T2-weighted images, they quantified intratumoral heterogeneity through texture parameters. Poorly differentiated squamous cell carcinomas demonstrated more

homogeneous texture patterns, whereas lymphomas exhibited higher entropy and contrast, indicating greater cellular heterogeneity. These imaging findings correlated with tumor biology and aggressiveness. The study emphasized that conventional MRI may not adequately detect subtle textural variations, while quantitative analysis enhances diagnostic capability. The authors concluded that MRI texture analysis serves as a noninvasive biomarker for predicting tumor grade and histological subtype, improving diagnostic precision and preoperative planning in adult neck masses (13).

Abo El-Atta et al. (2016) evaluated 45 patients with parotid gland tumors using multiphase CT and dynamic contrast-enhanced MRI, comparing findings with histopathology. MRI demonstrated superior soft-tissue contrast, tumor localization, and detection of internal heterogeneity and perineural spread, making it valuable for staging and surgical planning. It also provided insight into tumor vascularity and enhancement kinetics, aiding differentiation between benign and malignant lesions. Conversely, CT excelled in identifying calcifications, necrosis, and cortical bone erosion due to higher spatial resolution. Sensitivity was 94% for MRI and 92.6% for CT. The study concluded that CT and MRI are complementary modalities, and their combined use provides optimal diagnostic accuracy in evaluating adult neck masses (14).

Tartaglione et al. (2016) conducted a prospective study of 110 patients with parotid tumors using multiparametric MRI, including T2-weighted, diffusion-weighted, and dynamic contrast-enhanced sequences. Imaging parameters such as signal intensity, ADC values, and enhancement kinetics were used to assess tumor cellularity and vascularity. The technique achieved 89% sensitivity and 92% specificity in differentiating benign from malignant lesions. Pleomorphic adenomas showed high T2 signal and ADC values, whereas Warthin tumors demonstrated rapid enhancement and low ADC. Malignant

tumors exhibited heterogeneous signals and restricted diffusion. The authors concluded that multiparametric MRI could function as a noninvasive “virtual biopsy,” significantly enhancing diagnostic confidence and surgical planning in adult neck mass evaluation (15). Hoang et al. (2015) examined the reproducibility of apparent diffusion coefficient values in 50 patients with neck lesions using diffusion-weighted MRI across different systems. They found substantial variability of 20–25% within the same lesion due to technical factors such as magnetic field strength, b-values, and post-processing methods. This variability limits the reliability of ADC as a standalone diagnostic biomarker. The authors recommended interpreting ADC values alongside morphological MRI features, including lesion margins, internal structure, and enhancement patterns. They also highlighted the lack of standardized ADC thresholds across institutions, emphasizing the need for protocol standardization to ensure consistent and clinically meaningful application in neck mass assessment (16).

Gupta et al. (2021) conducted a clinico-radiopathological study involving 200 adults with neck masses, reporting that 91% of lesions were benign. The study highlighted the importance of integrating imaging with clinical evaluation and FNAC for accurate diagnosis. Ultrasound was commonly used as an initial modality, while CT and MRI were essential for complex or inconclusive cases. CT proved effective in detecting deep lesions, calcifications, and bone involvement, whereas MRI provided superior soft-tissue characterization and vascular assessment. Complementing this, Pynnonen et al. (2017) recommended early use of contrast-enhanced CT or MRI for suspicious masses, emphasizing imaging combined with clinical and cytological evaluation to optimize diagnosis, staging, and management (17–18).

Bagal et al. (2023) reported a high burden of head and neck cancers in India, with significant gender and age-related variations, underscoring the need for early evaluation of neck masses. Bhurgri et al. (2006) similarly documented high cancer incidence in Karachi, reinforcing the importance of imaging in early detection and staging. Alsibani et al. (2024), Chen et al. (2020), and Yabuuchi et al. (2008) emphasized the value of multimodal imaging, including CT, MRI, and PET-CT, in improving diagnostic accuracy. Additional studies by Koyuncu et al. (2003), Koontz et al. (2017), Baliyan et al. (2016), and Sakr et al. (2016) highlighted the complementary roles of structural and functional imaging, confirming that integrated approaches enhance characterization and management of adult neck masses (19–28).

Methodology

This study employed a cross-sectional descriptive design and was conducted at Integrated Medical Care Hospital, Lahore, over a duration of four months following synopsis approval. The calculated sample size was 73, based on a 95% confidence level ($Z = 1.96$), estimated prevalence of 5%, and a margin of error of 5%, as referenced by Thakur CK et al. (2024). A convenience sampling technique was used to recruit participants. Eligible participants included adult patients (≥ 18 years) presenting with palpable or clinically suspected neck masses, who were referred for both CT and MRI examinations, provided informed consent, and were medically fit to undergo imaging procedures.

Patients were excluded if they were below 18 years of age, unwilling to undergo imaging, had contraindications to MRI such as pacemakers or metallic implants, or were pregnant. All selected participants underwent standardized imaging protocols for both CT and MRI. CT imaging included non-contrast and contrast-enhanced scans using 100

mL of non-ionic iodinated contrast administered at 2 mL/sec, covering the region from the skull base to the thoracic inlet with slice thickness of 3–5 mm. MRI was performed using a 1.5 Tesla or higher system, incorporating T1-weighted, T2 fat-suppressed, diffusion-weighted imaging (DWI), and post-contrast T1 fat-suppressed sequences with slice thickness of 4–6 mm.

Data collection involved recording imaging findings from both CT and MRI, which were then compared against histopathological results as the gold standard. Independent variables included imaging modality, lesion characteristics (size, density, enhancement pattern, ADC values), contrast usage, and patient demographics. Dependent variables focused on diagnostic accuracy measures such as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy, along with correlation to histopathology. Data analysis was conducted using SPSS version 26.0, employing descriptive statistics and inferential tests including Chi-square and independent t-tests, with a p-value of <0.05 considered statistically significant.

Results

The study included 73 patients with neck masses, showing a near-equal gender distribution with a slight male predominance (53.4% males vs 46.6% females). This indicates that neck masses affect both genders almost equally, with only a minimal male dominance. Clinically, the most common presenting symptom was fever (47.9%), followed by pain (34.2%) and swelling (17.8%), suggesting that inflammatory and infective conditions are the predominant initial presentations. Additionally, the majority of patients (84.9%) had no prior history of neck surgery, indicating that most cases were primary rather than recurrent or post-surgical conditions.

Regarding final diagnoses, carcinoma was the most frequent (19.2%), followed by adenoma (16.4%), lymphadenopathy (11%), and other conditions such as abscess, cyst, goiter, and malformations (each 9.6%). Lipoma and lymphoma accounted for 8.2% and 6.8%, respectively. This distribution highlights a significant proportion of malignant cases among adult neck masses. Statistical analysis using the independent t-test showed no significant difference in age across diagnostic groups ($p > 0.05$), indicating that age alone is not a reliable factor in differentiating between types of neck masses, despite some variation in mean age among diagnoses.

CT imaging findings demonstrated a highly significant association with final diagnosis ($p < 0.001$). Lesion characteristics on CT, particularly morphology, were strongly predictive of pathological outcomes, with mass lesions being the most commonly detected. Similarly, CT enhancement patterns showed a statistically significant relationship with diagnosis ($p < 0.001$), confirming that contrast enhancement characteristics play a crucial role in differentiating between benign and malignant lesions. These findings emphasize CT's strength in identifying structural details such as calcifications, necrosis, and lesion extent.

Lymph node involvement also showed a strong association with final diagnosis ($p < 0.001$), particularly in malignant cases where increased nodal involvement was evident. This indicates that nodal changes are a key indicator of malignancy in neck masses. The data further reinforce the importance of CT in assessing nodal size, distribution, and metastatic spread, which are critical for staging and management decisions in patients with suspected malignant lesions.

MRI findings revealed a highly significant association between signal intensity patterns and final diagnosis ($p < 0.001$), demonstrating its superior capability in tissue

characterization. Different MRI signal patterns corresponded clearly with specific pathologies. Additionally, MRI tissue characterization showed a strong correlation with diagnosis ($p < 0.001$), effectively differentiating between various lesion types based on internal composition. These results confirm that MRI provides excellent soft tissue contrast and functional detail, making it highly effective for accurate diagnosis and differentiation of neck masses in adults.

Discussion

The discussion highlights that the study findings are consistent with established clinical guidelines emphasizing the critical role of imaging in the evaluation of adult neck masses. Early and accurate diagnosis relies heavily on appropriate radiological assessment. CT was identified as an effective first-line modality due to its ability to assess lesion size, morphology, extent, and enhancement patterns. MRI, on the other hand, provided superior soft tissue characterization and internal detail. The study demonstrated statistically significant correlations between imaging findings and final diagnosis, reinforcing that CT and MRI are complementary modalities that together enhance diagnostic accuracy and support informed clinical decision-making.

The results also support a structured and systematic diagnostic approach, as emphasized in existing literature. CT proved highly effective in evaluating structural features and lesion morphology, while MRI offered better visualization of soft tissue composition and internal architecture. This complementary role has been consistently reported in prior studies and was validated in the current research through strong statistical associations between imaging characteristics and final diagnoses. The combined use of CT and MRI improves diagnostic confidence, reduces uncertainty, and contributes to better patient outcomes by guiding appropriate management strategies.

Furthermore, the study reflects the diverse etiological spectrum of neck masses, including inflammatory, congenital, and neoplastic conditions. Imaging played a central role in differentiating these pathologies, with CT effectively identifying structural abnormalities such as calcifications and lesion extent, and MRI excelling in tissue characterization. The strong correlation between imaging parameters and histopathological outcomes confirms that integrating both modalities significantly improves diagnostic precision. This combined imaging approach minimizes the risk of misdiagnosis, particularly in distinguishing benign from malignant lesions, and ensures a more comprehensive clinical evaluation.

In conclusion, both CT and MRI are essential in the assessment of adult neck masses, each offering distinct diagnostic advantages. While CT is superior for evaluating morphology and structural details, MRI provides enhanced soft tissue differentiation. Their combined use leads to higher diagnostic accuracy and improved clinical decision-making. However, limitations such as small sample size, single-center design, lack of uniform histopathological confirmation, potential observer bias, and absence of long-term follow-up should be considered. Future studies should include larger, multi-center samples, standardized imaging protocols, and consistent histopathological correlation to strengthen evidence and optimize clinical application.

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