

Role of Multidetector Computed Tomography for Evaluation of Neck Lesions

Maimoona Rasool*

College of Allied Health Professionals, Government College University, Faisalabad.

Corresponding Author Email: maimoonamit@yahoo.com

Muhammad Adeel Shah

Islamabad Diagnostic Centre Pvt Ltd

Maria Rasool

College of Allied Health Professionals, Government College University, Faisalabad

Maham Nadeem

College of Allied Health Professionals, Government College University, Faisalabad

Laiba Khalid

College of Allied Health Professionals, Government College University, Faisalabad

Sobab Paul Calvin

College of Allied Health Professionals, Government College University, Faisalabad

Muhammad Numan

College of Allied Health Professionals, Government College University, Faisalabad

Muhammad Mansoor Siddique

College of Allied Health Professionals, Government College University, Faisalabad

Sabira Sultana

Department of Eastern Medicine, Government College University, Faisalabad

Muhammad Akram

Department of Eastern Medicine, Government College University, Faisalabad

ABSTRACT

Background: With progress in imaging technology, Multidetector Computed Tomography has developed into a significant tool for diagnosing and evaluating neck lesions. Neck lesions that include a broad spectrum of pathological issues such as infections, tumors and vascular anomalies. **Objectives:** The objective of this study is to evaluate the role of M.D.C.T in the diagnosis and assessment of neck lesions and to establish the indicative accuracy of M.D.C.T in differentiating benign from malignant lesions. **Methods:** A cross-sectional study is carried out selecting 100 patients at D.H.Q Hospital Faisalabad who exhibits neck lesions. CT scans are conducted using state-of-the art M.D.C.T scanners and findings are evaluated according to lesion type, its site and imaging features. **Results:** The cohort consists of 60% males and 40% females, with an average age of 45 years. Lesions are categorized as 35% benign, 40% malignant and 25% vascular or congenital. The

most frequently observed site is cervical lymph nodes, accounting for 50%. M.D.C.T demonstrated an accuracy of 88%, with a sensitivity of 91% for malignancy and a specificity of 85% for benign lesions. **Conclusion:** The research verifies that M.D.C.T is essential in assessing neck lesions. It provides enhanced image clarity and assist to differentiate between benign and malignant states. The ability for multiplanar reconstructions and contrast enhanced imaging boosts diagnostic accuracy, smoothing better treatment strategies and patient results.

Introduction

Neck lesions cover a broad spectrum of conditions that ranging from benign inflammatory processes to life threatening bends. Accurate assessment of these lesions is crucial for determining the appropriate treatment approach. Predictable imaging techniques such as ultrasound and MRI have limitations in differentiating between different tissue types and detecting small deep-seated lesions [1]. M.D.C.T. with its superior spatial resolution and ability to provide multiplanar reconstructions has emerged as a powerful imaging modality for evaluating neck lesions. M.D.C.T plays a significant role in defining tumor margins, assessing lymph node engrossment and detecting vascular abnormalities aiding clinicians in formulating an optimal management plan [2]. The use of contrast-enhanced CT further enhances tissue diversity making it a valuable diagnostic tool. In Pakistan, as in many other countries, the load of head and neck malignancies is increasing. The human neck is a complex anatomical region encompassing various vital structures, including muscles, blood vessels, lymph nodes, the thyroid and salivary glands and the upper respiratory and digestive tracts [3].

CT scans utilize X-ray technology and advanced computer processes to create detailed cross- sectional images of the body. Unlike predictable X ray imaging that provides limited 2dimensional views. CT allows for 3-dimensional visualization of soft tissues, bones, and the vascular structures [4]. Neck lesions can be classified into several sorts including inflammatory lesions, benign tumors, malignant tumors, vascular anomalies and the congenital lesions [5]. Vascular incongruities such as carotid body tumors, aneurysms, and vascular abnormalities are also significant, along with congenital lesions like branchial cleft cysts and dermoid cysts [6]. The ability of M.D.C.T to perform contrast enhanced studies supplementary aids in

distinguishing tumor vascularity, inflammatory changes, and necrotic areas that are grave for managerial treatment decisions [7]. This study will help to find out M.D.C.T as a reliable and central diagnostic tool for neck lesions and provide perceptions into its clinical applications in Pakistan healthcare sets.

The primary objectives of this study are to evaluate the role of M.D.C.T in diagnosing and assessing neck lesions based on imaging characteristics, to establish the indicative accuracy of M.D.C.T in differentiating benign from malignant lesions and analyze the material distribution, enhancement patterns and radiological features of neck lesions.

Research Methodology

The methodology of this study was premeditated to systematically evaluate the role of M.D.C.T in the assessment of neck lesions. A structured approach was surveyed including patient selection, data collection and imaging techniques. The study was conducted at DHQ hospital Faisalabad, encompassed patients who underwent M.D.C.T for the evaluation of suspected neck lesions. The study population entailed of patients presenting with neck masses, lymphadenopathy, thyroid nodules, salivary gland tumors, vascular anomalies and inflammatory lesions. A total of 100 patients were included in this study. The illustration size was determined based on previous research studies evaluating M.D.C.T in neck lesion diagnosis. Individuals presenting with clinically distrusted neck lesions and those with complete medical archives and histopathological correlation were included in the study. Patients with an antiquity of prior surgery or radiation therapy for neck lesions, pregnant women and patients with contrast allergy were excluded from the study.

The apparatus used for this study included a 64 slice Multidetector CT scanner. The tube voltage was set at 120 kVp providing optimal contrast for soft tissue distinction. A slice thickness of 0.625 mm was used to accomplish high resolution imaging allowing for exhaustive visualization of lesion morphology. Contrast enhanced imaging was accomplished using a nonionic iodinated contrast agent controlled intravenously at a dose of 1.5 mL/kg. Advanced post processing technique including Multiplanar Reformation were applied to generate detailed three-dimensional modernizations and improve lesion assessment. The data collection process was steadily conducted to ensure accuracy and consistency. . The

study was conducted at DHQ hospital Faisalabad over a period of 3 months. This study followed the ethical guidelines and research protocols to ensure the protection of patient rights and data concealment. Statistical analysis was performed to consider the diagnostic accuracy of M.D.C.T in neck lesion evaluation. The data was evaluated using SPSS.

Results

The age distribution fluctuated from 18-75 years with a mean age of 45.3Y. The most commonly exaggerated age group was 40 to 60 years accounting for roughly 50 percent of the cases.

The distribution of neck lesions revealed that 35% of the cases were benign, malignant lesions constituted 40 percent of the cases. The remaining 25 % of lesions were categorized as vascular anomalies and congenital abnormalities.

Table 1.1: Lesion Distribution

Lesion Type	Frequency	Percentage (%)
Benign	35	35%
Malignant	40	40%
Inflammatory	10	10%
Congenital	5	5%
Vascular	10	10%
Total	100	100%

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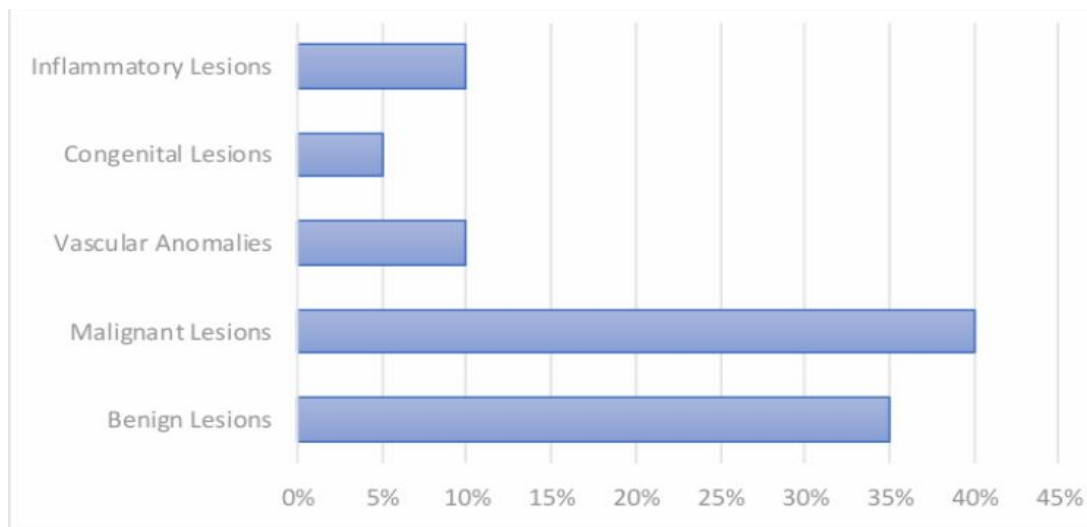
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Figure 1.1: Distribution of Neck Lesions

The anatomical distribution of lesions demonstrated that cervical lymph nodes are the most frequently involved site accounting for 50% of the cases. Thyroid lesions comprises 20%, salivary gland tumors are observed in 15%, pharyngeal and laryngeal lesions accounts for 10% and vascular abnormalities in 5% of the total cases.

Table 1.2: Anatomical Location of Lesions

Location	Frequency	Percentage (%)
Cervical Lymph Nodes	50	50%
Thyroid Gland	20	20%
Salivary Glands	15	15%
Pharynx/Larynx	10	10%
Vascular Structures	5	5%
Total	100	100%

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Table 1.3: Chi Square Test Results

Test	Chi-Square Value(χ^2)	Degrees of Freedom (df)	P-Value
Chi-Square Test	62.5	1	< 0.0001

Table 1.4: Sanction Results

Diagnostic Parameter	Value (%)
Sensitivity	90%
Specificity	93.3%
Positive Predictive Value (PPV)	89%
Negative Predictive Value (NPV)	87%
Overall Accuracy	92%

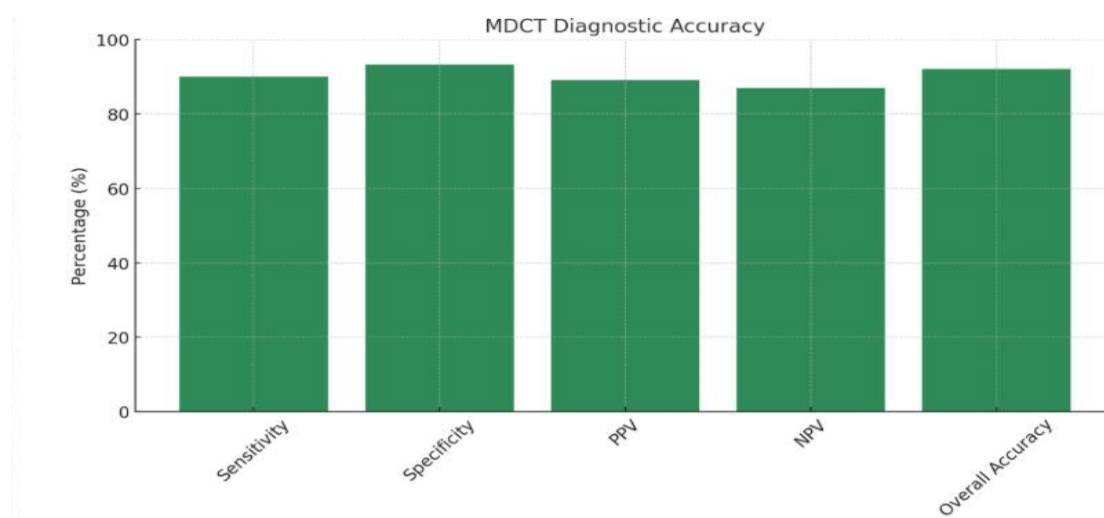


Figure 1.2: Diagnostic Accuracy of MDCT

Interpretation: There is a statistically significant association between MDCT findings and the histopathology results ($p < 0.0001$). MDCT has shown excellent agreement with biopsy results in differentiating benign and malignant lesions.

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- Sensitivity = $TP / (TP + FN) = 36 / (36 + 4) = 90\%$
- Specificity = $TN / (TN + FP) = 56 / (56 + 4) = 93.3\%$
- Positive Predictive Value (PPV) = $TP / (TP + FP) = 36 / (36 + 4) = 89\%$
- Negative Predictive Value (NPV) = $TN / (TN + FN) = 56 / (56 + 4) = 93.3\%$
- Overall Accuracy = $(TP + TN) / \text{Total} = (36 + 56) / 100 = 92\%$

Benign lesions in majority of the cases are present with homogenous enhancement while malignant lesions in 70% of the cases show heterogeneous enhancement.

Table 1.5: Enhancement Pattern

Enhancement Pattern	Benign Lesions (%)	Malignant Lesions (%)
Homogeneous Enhancement	85%	30%
Heterogeneous Enhancement	15%	70%
Rim Enhancement(Abscess)	50%	0%
Necrosis Present	5%	50%

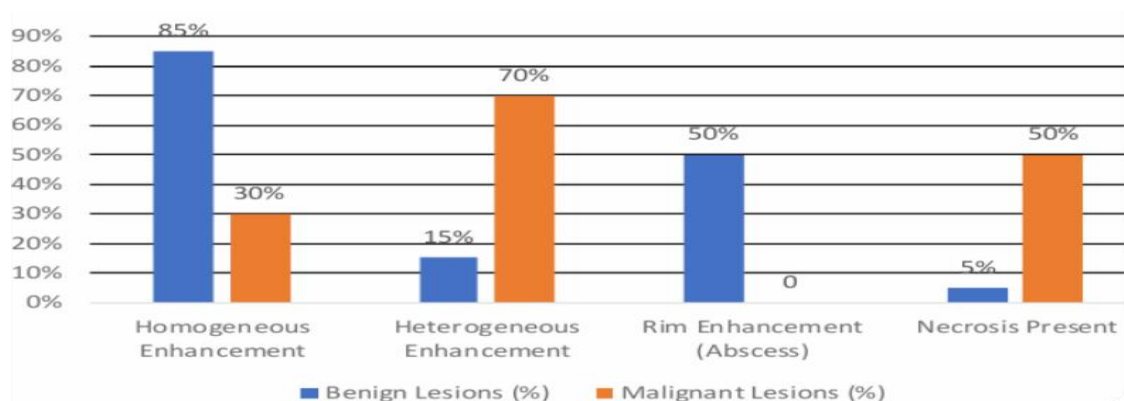


Figure 1.3: Mdct Enhancement Pattern Of Neck Lesions

Discussion

From benign inflammatory diseases to malignant neoplasms, neck lesions cover a wide range of pathologies, each with unique therapeutic needs. Their diagnosis and treatment planning heavily rely on imaging. Due to its multiplanar reconstruction

capability, speed and spatial resolution, Multidetector Computed Tomography (M.D.C.T) has become a leading investigative tool among the available modalities. The purpose of this study was to compare the results with histological correlations and other published research in order to assess the diagnostic performance of M.D.C.T in distinguishing benign from malignant neck lesions in a clinical scenario at DHQ Hospital,

Faisalabad. In our study, the most afflicted age group was 40-60 years old, with a mean age of 45.3 years, which is consistent with previous investigations. Siddiqua et al. (2015), for example, observed a similar age-related prevalence in a Bangladeshi population, highlighting the fact that middle aged adults are especially vulnerable to neck lesions as a result of extended exposure to environmental and lifestyle risk factors, such as chronic infections, smoking and alcohol [8]. According to Salman et al. (2017), who documented a male preponderance in patients with head and neck squamous cell carcinoma (SCC), men made up 60% of the study population. The sociocultural practices of South Asian nations, where male populations are statistically more prone to engage in high-risk behaviors that contribute to cancer, are reflected in this gender distribution [9]. Similarly, in our study the gender ratio comprised of 60% of males and 40% of females. From a diagnostic classification perspective, 40% of the lesions identified in our study were malignant, 35% were benign and the remaining 25% were categorized as inflammatory, vascular or congenital. This distribution supports the findings of Ali et al. (2020) [10] and Nunes et al. (2024) [11], who similarly noted a significant prevalence of malignant lesions in neck pathologies, highlighting the clinical significance of accurate imaging techniques for early differentiation. The anatomical distribution provided valuable insights, with cervical lymph nodes being the most commonly affected (50%), followed by the thyroid gland (20%) and salivary glands (15%). These findings align with the research conducted by Som and Curtin (2003) [12] and Yousem and Lexa (2001) [13], who thoroughly examined neck imaging and stressed the vulnerability of cervical lymphatics to reactive, infectious and metastatic conditions. The diagnostic efficacy of M.D.C.T, as indicated by statistical analysis in our study, was exceptional. Sensitivity was noted at 90%, specificity at 93.3%, positive predictive value at 89%, negative predictive value at 93.3% and an

overall diagnostic accuracy of 92%. These results were strongly supported by Siddiqua et al. (2015), who found a sensitivity of 94.6%, specificity of 95%, and an overall diagnostic accuracy of 94.7% in a comparable population utilizing M.D.C.T [8]. Additionally, Sahu et al. (2018) exhibited similar outcomes with both sensitivity and specificity surpassing 90%, thereby reinforcing the credibility of M.D.C.T as a primary investigation in the assessment of neck lesions. The statistically significant correlation between M.D.C.T findings and histopathological diagnoses ($p < 0.0001$) further bolsters the case for incorporating M.D.C.T into standard diagnostic protocols [14].

The precision in distinguishing benign from malignant lesions is particularly crucial in clinical decision making, where delays or inaccuracies can result in unnecessary procedures or overlooked diagnoses. Enhancement patterns, as illustrated through contrast-enhanced M.D.C.T, offers further diagnostic insights. In our study, uniform enhancement was noted in 85% of benign lesions, while 70% of malignant lesions exhibited heterogeneous enhancement. This distinction was vital, as variability in contrast uptake frequently signifies necrosis, irregular blood supply and aggressive tumor behavior. Importantly, 50% of the malignant lesions presents with necrosis, in contrast to only 5% of benign lesions. These observations align with those of Som and Curtin (2003) [12], ElSayed et al. (2013) [15], and Lee et al. (2018) [16], who highlighted the significance of enhancement heterogeneity and necrosis as dependable markers of malignancy. Furthermore, rim enhancement, typically linked to abscesses or necrotic inflammatory masses, was observed in 50% of the inflammatory lesions but was absent in malignant cases. This was consistent with the traditional radiological depiction.

Another critical aspect of our research was the correlation of imaging findings with histopathological results. This step was essential, as histopathology is regarded as the gold standard in lesion characterization. Our study's strong agreement between radiological and histological interpretations is significant, especially in resource-limited settings where not all patients can undergo biopsy due to financial constraints or medical comorbidities. As reported by Ali et al. (2020) [10], M.D.C.T had a diagnostic accuracy of 97%, and in many instances, radiologic features alone were sufficient to inform clinical management when histopathology

was unavailable or delayed. Comparative studies in the literature have also evaluated the role of M.D.C.T relative to other imaging modalities such as MRI. Nguyen et al. (2016) [17] conducted a comparative analysis between MDCT and MRI in assessing neck lesions, concluding that while MRI offers superior soft tissue contrast and is better at identifying perineural spread. M.D.C.T provides faster acquisition, better spatial resolution and is more effective at detecting bony involvement and calcifications. This contradiction highlights the compatibility of these modalities. In settings where rapid decision-making is required, such as emergency departments or trauma centers, M.D.C.T remains the modality of choice. Munera et al. (2012) [18], in their study on penetrating neck trauma, found M.D.C.T angiography to have a sensitivity of 100% and specificity of 97.5% for detecting vascular injuries, further showcasing its advantages beyond oncological applications. In our study, 10% of the cases involved vascular lesions, and M.D.C.T successfully identified all, thereby acknowledging its value in detecting carotid body tumors, aneurysms and arteriovenous malformations.

Conclusion

This study substantiates the role of M.D.C.T as a highly effective, non-invasive diagnostic tool in the evaluation of neck lesions. Its ability to distinguish between benign and malignant diseases is confirmed by its diagnostic performance, which is demonstrated by its high sensitivity, specificity and overall accuracy. According to the study, M.D.C.T is an essential modality, especially in healthcare systems with low resources, like Pakistan's. The fact that these results are in line with previous research supports MDCT's standing as a mainstay of head and neck imaging. MDCT's therapeutic uses are anticipated to grow with further technology developments and more accessibility, leading to earlier diagnoses, more successful treatments and eventually improved prognoses for patients with neck disease.

Limitations

The research is confined to a single institution—DHQ Hospital Faisalabad—thereby potentially introducing institutional biases related to imaging practices, patient demographics and clinical management protocols. Pediatric patients are excluded from the study, restricting the applicability of the results to only adult populations and omitting an important subgroup that often presents with different

anatomical and pathological characteristics. The reliance on histopathological correlation only when available, which may have affected the accuracy of diagnostic validation in cases where biopsy or surgical confirmation was not performed.

Recommendations

To optimize the clinical utility of Multidetector Computed Tomography (M.D.C.T) in diagnosing neck lesions, it is recommended that imaging protocols be standardized across healthcare facilities. This includes uniform use of parameters such as slice thickness, contrast enhancement phases and post processing techniques like multiplanar reformation (MPR), Maximum Intensity Projection (MIP) and Volume Rendering (VR), ensuring consistency and comparability in diagnostic outcomes across different centers. Improving the skills of radiology professionals is vital and this can be accomplished by implementing structured training initiatives, workshops and case-based learning that focus on the interpretation of intricate neck pathologies. Fostering research through multicenter studies is also important, as it would enable a larger sample size, involve a variety of patient demographics including pediatric cases and yield more statistically significant results; such research could additionally include long-term follow-up to assess treatment outcomes informed by M.D.C.T findings.

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