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Original Research Paper

Radiology

# PERFUSION CT IN THE EVALUATION OF NECK MASSES

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**ABSTRACT** Neck cancer is among the most prevalent carcinomas globally, with squamous cell carcinoma being the predominant type. Two-thirds of cases are diagnosed at advanced stages, making early detection critical to provide optimal treatment. Angiogenesis is pivotal in cancer growth/metastases and is typically assessed through invasive microvascular density (MVD) evaluation which is an invasive procedure with limitation in routine use. This study investigates the role of perfusion CT in characterizing neck masses by correlating perfusion parameters with histopathological findings. A prospective study was conducted on 30 patients with neck masses. Perfusion parameters—blood flow (BF), blood volume (BV), mean transit time (MTT), and permeability surface area product (PMB)—were quantified and compared with biopsy or surgical specimen results. Results showed that malignant lesions exhibited significantly higher BF, BV, and PMB, and shorter MTT compared to benign lesions, aiding in differentiation. The study underscores the clinical relevance of perfusion CT in diagnosing and staging neck masses, suggesting it as a valuable tool for improving diagnostic accuracy and treatment planning.

**KEYWORDS :** Perfusion, computed tomography, neck mass, tumor vascularity

## INTRODUCTION

Neck cancer ranks among the most prevalent carcinomas globally, affecting both males and females, with squamous cell carcinoma being the predominant type. Sadly, around two-thirds of cases manifest in advanced stages (III and IV).[1] Angiogenesis is pivotal in cancer growth/metastases and is typically assessed through invasive microvascular density (MVD) evaluation which is an invasive procedure with limitation in routine use.[2] Contrast enhanced Computed Tomography (CT) Scan is integral in diagnosing, staging, and monitoring neck masses, yet distinguishing between benign and malignant lesions remains challenging. CT perfusion, introduced in 1980, has undergone continuous refinement.[3] By quantifying abnormal vasculature, perfusion CT may enable the assessment of tumor aggressiveness.[4]

### Aims And Objectives

Our study investigated the role of perfusion CT in characterizing neck masses by correlating perfusion parameters with histopathological findings from biopsies or surgical specimens.

## MATERIAL AND METHODS

A prospective study was conducted on 30 patients with a clinical diagnosis of neck mass. The study was conducted for a duration of 12 months. The procedure was explained to the patient and written informed consent in the vernacular language was taken.

### Inclusion Criteria:

1. New patients referred with a diagnosis of neck mass/tumor age more than 18yr.
2. Patient's willingness to participate in the study.

### Exclusion Criteria:

1. Patients not willing to participate in the study.
2. Patients with altered renal function.
3. Patients with significant allergic history and past history of contrast allergy.
4. Patients having recurrence of neck tumor.

The study utilized a 128-slice SIEMENS DEFINITION CT scanner to assess neck masses. Initially, a non-contrast scan localized the area of interest, followed by perfusion CT employing a dedicated protocol. The protocol involved a cine CT acquisition concurrently with intravenous contrast injection (50 ml of low osmolar nonionic contrast at 5 ml/s, followed by 30 ml of saline chase using a dual head pressure injector).

Dynamic CT acquisition began 4 seconds after contrast injection, lasting approximately 42 seconds, with parameters set at 100 kV, 150 mAs, and 0.6 mm collimation. Additionally, routine CECT images of the entire neck were obtained.

Conventional NCCT and CECT images were analyzed for lesion characterization, including location, shape, margins, attenuation, enhancement pattern, necrosis, and lymphadenopathy.

For the quantification of neck perfusion and for the generation of blood-flow maps, the acquired data was loaded on to a separate workstation with dedicated body CT perfusion software.

Perfusion maps of the neck were then generated. Perfusion parameters were quantified by placing regions of interest within solid enhancing areas of lesions and normal neck muscles for comparison.

Following parameters were evaluated **(Figure 1)**:

1. **Blood flow (BF)** (ml/100ml/min) - blood flow transiting from arterial input through the tissue.
2. **Blood volume (BV)** (ml/100ml) - volume of flowing/moving blood within tissue vasculature.
3. **Mean transit time (MTT)** (seconds) - average time taken to travel from artery through tissue microvasculature to vein.
4. **Permeability surface area product (PMB)** (ml/100ml/min) - total flow from plasma to interstitial space.

Comparative analysis of the obtained results was done with histopathological findings.

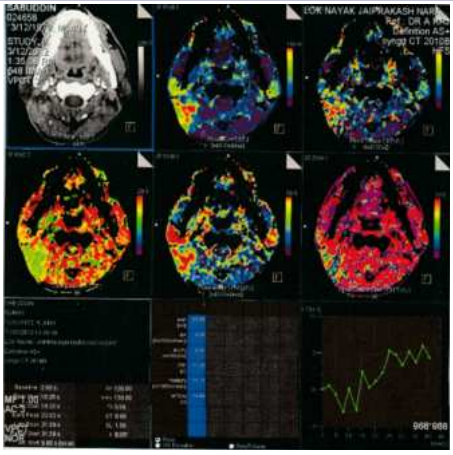

**Figure 1:** Perfusion CT map shows colour maps for blood flow (BF), blood vloume (Bv), mean transit time (MTT) and permeability (pMB) generated by software, in which every pixel is assigned a colour that represents a numeric value for the perfusion parameter calculated for that voxel. High numeric values are represented by colour shades of yellow and red, and low numeric values are represented by color shades of green and blue.

## RESULTS

A comprehensive study was conducted involving 30 patients with neck masses, all of whom underwent non-contrast, perfusion, and contrast-enhanced scans of the neck. Final histopathological diagnoses were confirmed via biopsy/FNAC or surgical resection. Malignant lesions accounted for 86.66% (26/30) of cases, with laryngeal squamous cell carcinoma **(Figure 2)** being the most prevalent subtype (46.67%). Benign lesions constituted 13.33% (4/30) of cases, with pleomorphic adenoma **(Figure 3)** being the most common (10%). The larynx was the most common site of malignant lesions (53.84%), with 100% of these cases being squamous cell carcinomas. Metastatic lymph nodes were commonly found in the carotid space (62.50%).

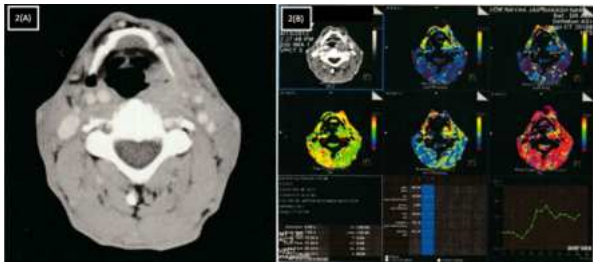

**Figure 2:** Squamous cell carcinoma larynx (well differentiated). (A) Axial contrast enhanced CT scan showing heterogeneously enhancing mass (arrow) involving left side supraglottic larynx. (B) On perfusion CT map, the Iesion stands out clearly. The perfusion values from the tumor (ROI) reveals high tumor blood flow (46.12 ml/100g/min), blood volume (4.21 ml/100g), permeability 21.19ml/100g/min) and low mean transit time (3.17 s)

Most lesions appeared isodense on NCCT (76.66%). Carcinoma of the larynx frequently involved the supra-glottic region (35.71%), and 57.14% of cases involved multiple regions of the larynx. The majority of malignant lesions showed irregular shape (76.92%) and ill-defined margins (80.76%) on CECT. Necrotic changes were present in 46.15% of malignant lesions.

Perfusion parameters from normal paraspinal or sternocleidomastoid muscles revealed mean blood flow of 9.74±6.45 ml/100ml/min, mean blood volume of 1.75±0.88 ml/100ml, mean permeability of 9.24±5.03 ml/100ml/min, and mean transit time of 14.31±5.75 seconds.

In malignant lesions, primary squamous cell carcinoma showed mean blood flow of 47.29±26.52 ml/100ml/min, mean blood volume of 7.94±6.49 ml/100ml, mean permeability of 24.94±10.69 ml/100ml/min, and mean transit time of 2.74±0.63 seconds. Metastatic lymph nodes exhibited mean blood flow of 38.86±16.16 ml/100ml/min, mean blood volume of 4.83±2.62 ml/100ml, and mean transit time of 2.95±0.49 seconds. Malignant lesions demonstrated higher mean blood flow, blood volume, and permeability compared to benign lesions, while benign lesions showed longer mean transit time (p value < 0.05). Metastatic lymph nodes exhibited higher mean blood flow, blood volume, and permeability compared to benign lymph nodes, with a shorter mean transit time (p value < 0.05).

**Table 1: Comparison of Perfusion Parameters Between Malignant And Benign Lesions. (n=30)**

| Perfusion parameters | Malignant lesions (n=26) | Benign lesions (n=4) |
|---|---|---|
| BF (ml/100ml/min) | | |
| Range | 4.5-90.47 | 8.31-29.43 |
| Mean±SD | 42.05±24.28 | 21.34±9.43 |
| BV (ml/100ml) | | |
| Range | 1.38-26.11 | 2.04-4.60 |
| Mean±SD | 6.50±5.59 | 3.62±1.1 |
| PMB (ml/100ml/min) | | |
| Range | 3.29-49.49 | 13.94-18.89 |
| Mean±SD | 24.09±10.64 | 15.68±2.22 |
| MTT (seconds) | | |
| Range | 1.68-04.02 | 4.89-10.01 |
| Mean±SD | 2.79±0.57 | 7.72±2.19 |

Perfusion CT thus provided valuable insights into the vascular characteristics of neck lesions, aiding in the differentiation between benign and malignant lesions and guiding treatment decisions.

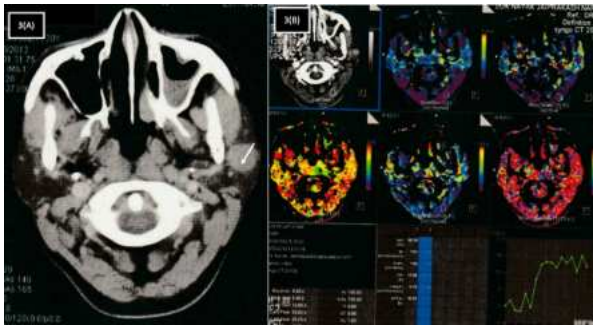

**Figure 3:** Pleomorphic adenoma. (A) Axial contrast CT scan of the neck showing a well-defined hypodense mass lesion with in the substance of the left parotid (arrow). (B) On perfusion CT maps, the tumor shows mildly elevated perfusion parameters (blood flow of 20.68ml/100g/min, blood volume of 3.83ml/100g, permeability of 13.34ml/100g/min and transit time of 10.01s).

## DISCUSSION

This study on the role of perfusion CT in evaluating neck masses offers significant insights into its potential clinical application and diagnostic value. By comparing perfusion parameters between malignant and benign lesions, the study sheds light on the functional characteristics of these lesions.

Firstly, the study underscored the limitations of relying solely on anatomic imaging for diagnosing head and neck lesions. It emphasized the challenges associated with early lesion detection and the potential for large non-neoplastic processes to morphologically mimic neoplastic lesions. In this context, perfusion CT can emerge as a valuable tool for providing

functional evaluation by measuring tissue vascularity.

The evolution of perfusion CT from being primarily a research tool to being clinically available through commercial software packages highlights its increasing recognition and importance in various clinical settings. The study design, including patient demographics and lesion characteristics, provides essential context for interpreting the findings. Notably, the distribution of malignant and benign lesions, along with the specific histological subtypes included in the analysis, enriches the comprehensiveness of the study.

The comparison of perfusion parameters between malignant and benign lesions revealed significant differences, with malignant lesions demonstrating higher mean blood flow, blood volume, and permeability, as well as shorter mean transit time. These findings suggested that perfusion CT has the potential to aid in lesion differentiation and characterization, contributing to more accurate diagnoses and treatment planning.

In comparison to a landmark study from 2010 by Bisdas et al., which established the foundational role of perfusion CT in distinguishing between malignant and benign neck masses, the current research reaffirms and builds upon those findings[6]. Bisdas et al. reported similar observations regarding higher blood flow and permeability in malignant lesions. However, the present study offers updated insights with more refined perfusion parameters, as technological advancements have made perfusion CT software more accessible and precise.

Zima et al. in 2012 compared perfusion CT to other functional imaging modalities like PET-CT and highlighted perfusion CT's growing potential in tumor characterization[7].

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## CONCLUSION

In conclusion, the study underscores the relevance of perfusion CT in clinical decision-making for neck masses. It identifies areas for future research, such as standardization of analysis methods and software implementation, ensuring a forward-looking perspective on the topic. Overall, the study contributes valuable knowledge to the field of radiology and highlights the potential of perfusion CT as a complementary tool in lesion evaluation.

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