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# Comparative Study Of Contrast Enhanced Computed Tomography And Ultrasonography With Colour Doppler In Assessing Thyroid Cartilage Invasion And Strap Muscle Involvement In Laryngeal Carcinoma In A Tertiary Care Hospital In Chengalpattu District, Tamilnadu

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**ABSTRACT:**
**Introduction**: Laryngeal cancers account for about one-third of head and neck cancers and 3-6% of cancers in men in India, with over 90% being squamous cell carcinomas. Tobacco smoking and alcohol consumption are major risk factors. CT scans are often used to detect thyroid cartilage invasion, critical for treatment planning, while ultrasonography is a valuable tool for assessing neck pathologies, offering high resolution and safety. It is especially useful for evaluating cancer spread, lymph node metastasis, and involvement of the carotid wall or strap muscles.
**Aims and objective**: The main aim of this study is to evaluate the effectiveness of CECT with USG findings with colour doppler in assessing the thyroid cartilage invasion and strap muscle involvement in patients of carcinoma larynx.
**Materials and methods**: In this prospective study, 40 patients referred to our institute underwent US with colour doppler and CECT for staging laryngeal carcinoma. Out of the 40 patients, 34 were males and 6 were females with 23 of them had a history of tobacco usage. Histopathologic results were used as the reference standard for comparison and statistical analysis.
**Conclusion**: US with colour doppler serves as a reliable imaging modality for evaluating thyroid cartilage invasion in laryngeal carcinomas. It can be used as a complementary tool alongside CECT to definitively detect thyroid cartilage invasion, aiding in treatment planning.

**Keywords:** laryngeal carcinoma, CECT, US, colour doppler.

## INTRODUCTION:

Laryngeal cancers make up nearly one-third of all head and neck cancers, with 3-6% of all cancers in men in India being laryngeal. Over 90% of these cancers are squamous cell carcinomas, with tobacco smoking and alcohol consumption being significant risk factors. CT scans are commonly used to detect thyroid cartilage invasion, which is crucial for determining treatment strategies [1]. Ultrasonography is another valuable imaging tool for assessing neck pathologies, offering high resolution, safety, and availability. It is particularly useful for evaluating the spread of advanced cancers, subclinical lymph node metastasis, and carotid wall or strap muscle involvement. While CT and MRI both help in evaluating disease extent, MRI provides better soft tissue resolution but is limited by high cost, availability, and scanning time. It is also contraindicated for certain patients, including those with pacemakers. MRI's specificity for detecting thyroid cartilage invasion is lower due to common inflammatory changes and the possibility of false positives.

Ultrasound with Colour Doppler is an important imaging tool in the diagnosis and management of laryngeal carcinoma. It helps in detecting laryngeal masses, assessing their size, and evaluating the extent of tumor infiltration into surrounding tissues. The Color Doppler feature is particularly valuable for assessing the vascularity of the tumor, as malignant lesions

like laryngeal carcinoma often show increased blood flow compared to benign conditions. This imaging technique also plays a critical role in evaluating cartilage invasion, regional lymph nodes for metastasis, helping to identify enlarged or abnormally vascular nodes that may indicate cancer spread [3]. Although ultrasound provides real-time, non-invasive imaging with relatively low cost, its ability to visualize deep structures is limited compared to other imaging methods like CT or MRI. Despite these limitations, it remains a valuable tool for monitoring tumour progression and lymph node involvement in patients with laryngeal carcinoma.
Contrast-enhanced computed tomography (CECT) is a crucial imaging modality in the diagnosis, staging, and treatment planning of laryngeal carcinoma. It provides detailed cross-sectional images of the larynx and surrounding structures, allowing for accurate visualization of the tumor's size, location, and extent of invasion into adjacent tissues such as the pharynx, neck, and thyroid [4]. CECT is particularly useful in assessing the involvement of regional lymph nodes, detecting enlarged or metastatic nodes, and evaluating the extent of vascular invasion. The use of contrast enhances the visibility of blood vessels, tumors, and any areas of abnormal tissue, providing valuable information for staging the cancer and determining the appropriate course of treatment, whether surgical, radiological, or a combination of both. CECT also aids in monitoring post-treatment changes and detecting any recurrence of the disease.

The most common imaging modality for staging laryngeal carcinoma is contrast-enhanced CT (CECT), with early-stage cancers treated with the aim of preserving the larynx. For cases with limited cartilage invasion, function-preserving treatments such as partial laryngectomy or chemoradiotherapy are now being used, while advanced stages with significant invasion typically require total laryngectomy [5,6]. The main aim of this study is to evaluate the effectiveness of CECT with USG findings in assessing the thyroid cartilage invasion and strap muscle involvement in patients of carcinoma larynx.

**MATERIALS AND METHODS:**
This is a cross-sectional study with a total of forty patients with laryngeal carcinoma which is biopsy proven. This study has been done in Department of Radiodiagnosis for a period of six months. The patients were included in this study based on the following criteria.

**Inclusion criteria:**
- All symptomatic and biopsy proven case of carcinoma larynx .
- Those who gave consent to be part of study.

**Exclusion criteria:**
- Patients had on radiation therapy and chemotherapy without surgery after endoscopic biopsy for carcinoma laryn
- Post operative ca larynx patients.
- Patients who did not want to be a part of study
- All patients with absolute contraindication to contrast media (I.E., patients with renal failure, impaired renal function and contrast allergy)

Gray-scale and colour doppler ultrasound was performed in all patients using high frequency (7–12 MHz ) curvilinear probe for neck sonography (E SAOTE). The procedure of ultrasound with Color Doppler for carcinoma of the larynx typically begins with the patient positioned comfortably, often lying down with their neck exposed. The ultrasound probe is gently moved over the neck, specifically targeting the laryngeal region and surrounding structures [7]. The physician uses the probe to visualize the larynx and surrounding soft tissues, assessing for any masses, thickening, or irregularities that may indicate carcinoma. The Color Doppler feature is activated to assess blood flow, highlighting areas with increased vascularity, which is common in malignant tumors. Additionally, Doppler imaging is used to evaluate regional lymph nodes for any signs of metastasis, detecting enlarged or hypervascular nodes that may be indicative of cancer spread. The procedure is non-invasive, relatively quick, and provides real-time images, making it a valuable tool for assessing tumor characteristics, staging the disease, and guiding biopsy procedures.
Consented patients underwent an initial plain and contrast-enhanced CT study of the neck using a 32-slice CT scanner (SEIMENS SOMATOM). The contrast agent used is OMNIPAQUE, with a concentration of 350 mg I/ml. The dosage administered ranges from 1 to 1.5 ml per kg of body weight. For the procedure, an 18 G IV cannula is inserted, and the contrast is injected using a 2 ml and 10 ml syringe with the help of an Easy Fix pressure injector (single head Medrad). This setup ensures precise and controlled administration of the contrast agent for optimal imaging of the neck region. The procedure for contrast-enhanced computed tomography of the larynx begins with the patient being positioned on the CT table, usually lying flat on their back with the neck extended for clear imaging of the laryngeal region [8]. A contrast agent, typically iodine-based, is injected intravenously to enhance the visibility of blood vessels, tumors, and surrounding structures. As the contrast material circulates, the CT scanner takes a series of detailed cross-sectional images of the larynx and neck, capturing information on the tumor's size, location, and any invasion into adjacent tissues. The scan also helps assess the condition of nearby lymph nodes, checking for enlargement or metastasis. The procedure is non-invasive, typically takes only a few minutes, and provides valuable diagnostic information that aids in staging the cancer, planning treatment, and monitoring for recurrence.

The results of thyroid cartilage assessment were marked as no involvement, minor involvement, and major involvement. Cortical irregularity and erosion of only inner cortex were considered minor involvement. Asymmetrical sclerosis, erosion through both inner and outer cortices, lysis, and presence of enhancing lesion on both sides of cartilage depicting extra laryngeal spread through the cartilage were considered the criteria for major cartilage erosion

Data will be gathered and input into the Statistical Package for the Social Sciences (SPSS, version 25). The data will be analyzed statistically, with descriptive measures including range, mean, standard deviation, frequencies (number of cases), and percentages, as applicable. The sensitivity, specificity, accuracy, positive predictive value, and negative predictive value for CECT and ultrasound will be computed individually for each parameter.

**RESULTS:**
In our study we have 40 cases of laryngeal carcinoma referred to our department for neck evaluation. The demographic data has been depicted in table 1,2 and 3. The mean age in our study was 57.8 ± 7.48 (mean ± SD).

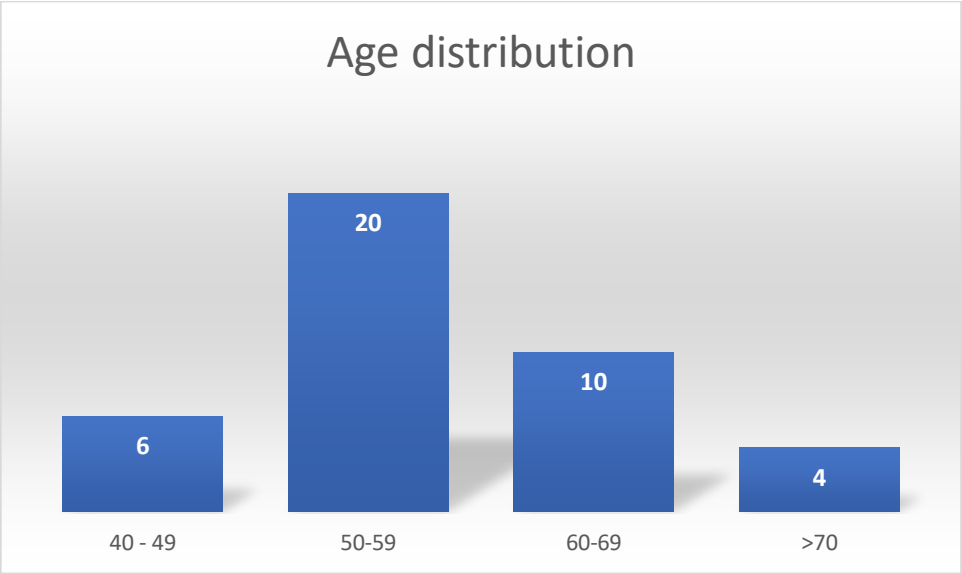



**Table 1:** Age distribution

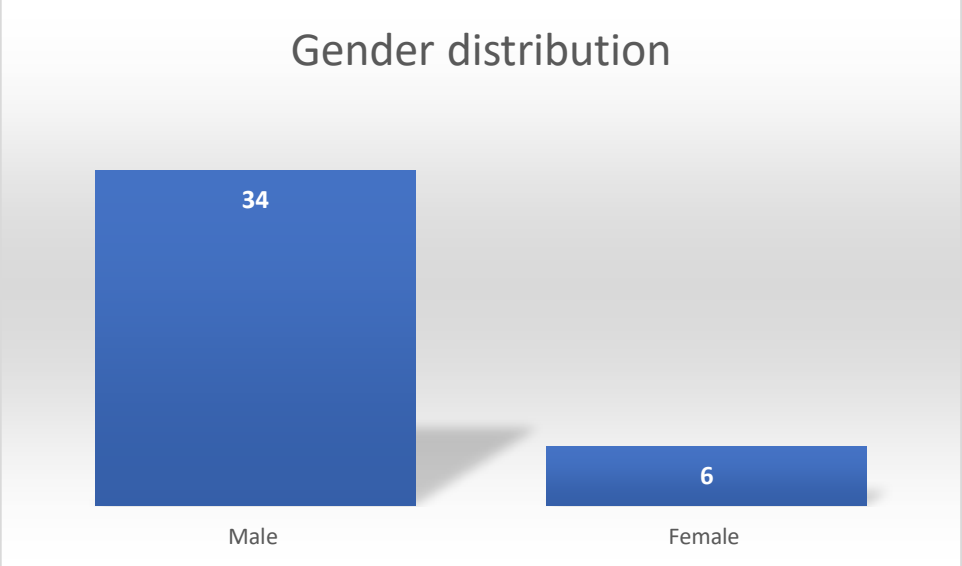



**Table 2:** Gender distribution

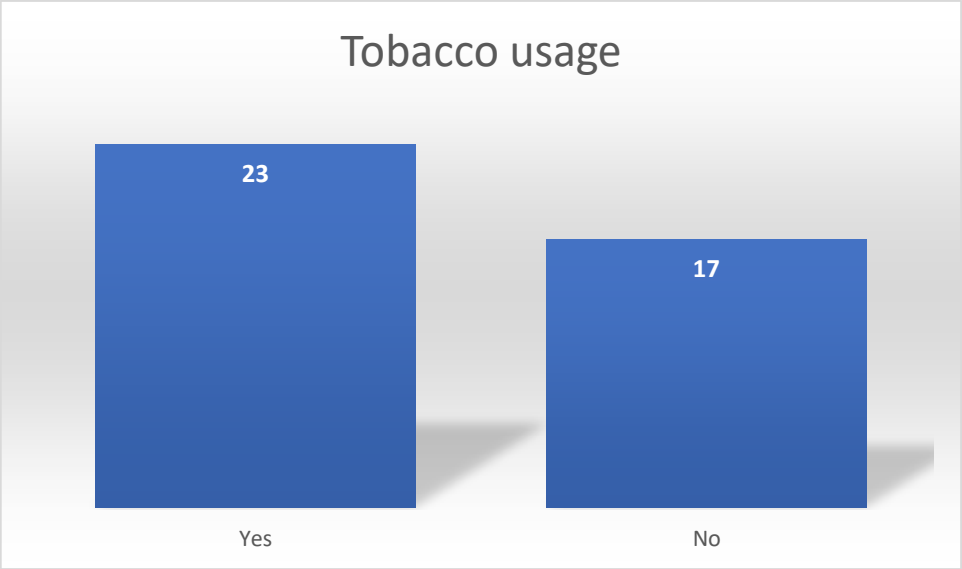



**Table 3:** Tobacco usage

Computed tomography found minor cartilage invasion in total of 17 cases out of which pathology confirmed superficial invasion in 10 cases and no invasion in the 5 cases and major invasion in 1 case. Ultrasound with doppler found minor cartilage invasion in total of 17 cases out of which pathology confirmed superficial invasion in 11 cases and no invasion in the 4 cases and major invasion in 1 case.
Statistical formula values at 95% CI (confidence limit) for thyroid cartilage invasion detected on CT when compared to the reference standard HPE are:
Sensitivity: 86.11%.
Specificity: 75.00%.
Positive likelihood ratio: 3.44.
Negative likelihood ratio: 0.19.
Positive predictive value: 96.88%.
Negative predictive value: 37.50%.
Statistical formula values at 95% CI for thyroid cartilage invasion detected on ultrasound with doppler when compared to the reference standard HPE are:
Sensitivity: 88.57%.
Specificity: 80.00%.
Positive likelihood ratio: 4.43.
Negative likelihood ratio: 0.14.
Positive predictive value: 96.88%.
Negative predictive value: 50.00%.

**Table 4:** CECT vs HPE

| CT/HPE | Major invasion | Minor invasion | No invasion | Total |
|---|---|---|---|---|
| Major invasion | 20 | 0 | 0 | 20 |
| Minor invasion | 1 | 10 | 5 | 17 |
| No invasion | 0 | 1 | 3 | 3 |
| Total | 21 | 11 | 8 | 40 |

**Table 5**: USG vs HPE

| USG/HPE | Major invasion | Minor invasion | No invasion | Total |
|---|---|---|---|---|
| Major invasion | 20 | 0 | 0 | 20 |
| Minor invasion | 1 | 11 | 4 | 17 |
| No invasion | 0 | 0 | 4 | 3 |
| Total | 21 | 11 | 8 | 40 |

**Table 6:** Statistical analysis of contrast enhaced computed tomography results in detecting minor cartilage invasion

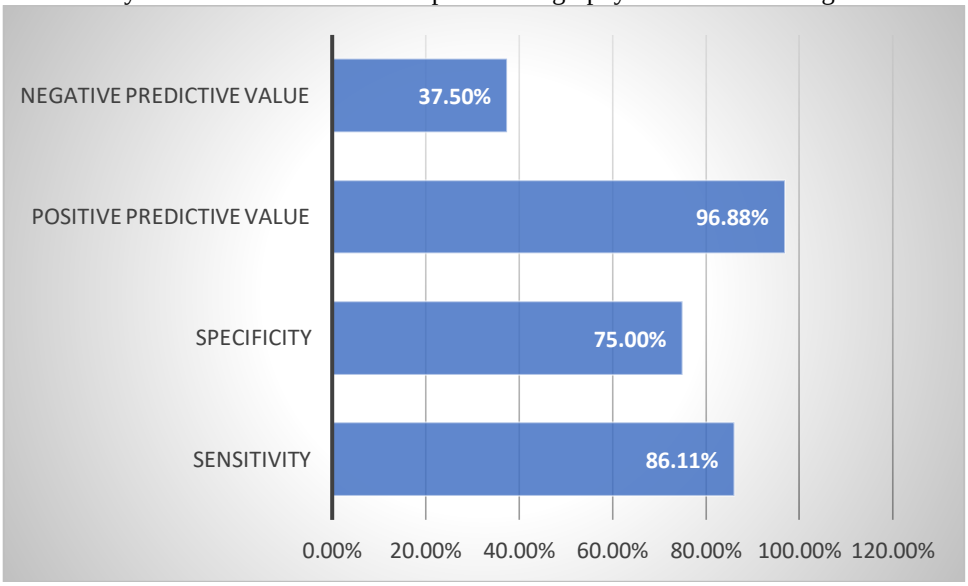
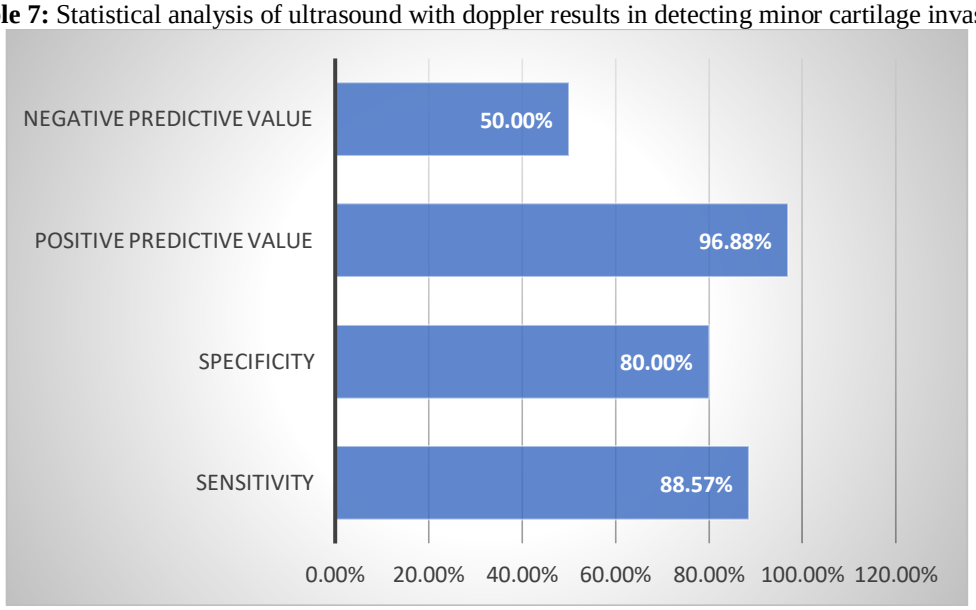



**Table 7:** Statistical analysis of ultrasound with doppler results in detecting minor cartilage invasion




**DISCUSSION:**

In this study, we compared the diagnostic accuracy of CECT and US with colour doppler with HPE in detecting thyroid cartilage invasion in laryngeal carcinoma. In the early 90s, Computed Tomography demonstrated high specificity but lower sensitivity in assessing thyroid cartilage invasion [9,10]. In the late 90s, new criteria for erosion, lysis, and extra laryngeal spread were introduced, which improved sensitivity and specificity.

Following significant advancements in Computed Tomography technology, Li et al. [11] reported a sensitivity of 85% and specificity of 75% with multidetector Computed Tomography. In our study, using the established criteria for cartilage invasion and multidetector Computed Tomography, we achieved a sensitivity of 91%, specificity of 75%, a positive predictive value of 98%, and a negative predictive value of 38%.

However, in a recent review by Adolphs et al., [12] which included four studies, only one study assessed the positive and negative predictive values for any laryngeal cartilage invasion, reporting values of 87% and 56%, respectively.

Three studies evaluated the positive and negative predictive values for thyroid cartilage invasion, with positive predictive values ranging from 44% to 80%, and negative predictive values ranging from 85% to 100%. The differences in the positive and negative predictive values between this and our study can be attributed to the smaller sample size in our research.

The detection rate and specificity were identical for both CECT and US with colour doppler. While US with colour doppler showed higher sensitivity compared to CECT, the difference was not statistically significant ($P > 0.05$).

**CONCLUSION:**

Both US with colour doppler and CECT demonstrate good diagnostic accuracy in assessing thyroid cartilage invasion. US with colour doppler is more sensitive than CECT in detecting thyroid cartilage invasion, though the difference is not statistically significant. Thus, US with colour doppler serves as a reliable imaging modality for evaluating thyroid cartilage invasion in laryngeal carcinomas. It can be used as a complementary tool alongside CECT to definitively detect thyroid cartilage invasion, aiding in treatment planning.

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