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Research Article

SENSITIVITY OF COMPUTED TOMOGRAPHY AS A DIAGNOSTIC TOOL IN DIFFERENTIATING NECK MASSES INTO BENIGN AND MALIGNANT LESIONS

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ABSTRACT

Objective: Neck masses have a diverse clinical profile that necessitates multimodality evaluation. Hence, the present study aids the use of computed tomography (CT) in identifying various structures in the neck, which are split into multiple regions by the cervical fascia.

Methods: This multi-centric study was conducted at two tertiary care centers. Sixty patients were studied who were referred to the radiodiagnosis department for evaluation. In the present study, CT findings were correlated with pathological findings.

Results: The results revealed that the sensitivity of CT in diagnosing and differentiating the neck mass was 86.3% and a positive predictive value of 100%, with a negative predictive value of 95.1%. Cross-sectional imaging of the CT of the neck provides detailed three-dimensional visualization of the masses and their relationship with adjacent blood vessels, glands, fascia, muscles, and neck spaces. The posterior extension of the lesion is better assessed by CT and surpasses ultrasonography.

Conclusion: Bony involvement, either by a primary bony lesion or a direct invasion by the neck mass, can be better evaluated because of the differential attenuation values in CT.

Keywords: Computed tomography, Neck masses, Neck spaces, Benign, Malignant.

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INTRODUCTION

Neck masses have varied clinical presentations, requiring multimodality assessment for their evaluation. Computed tomography (CT) helps delineate various structures in the neck surrounded by the fat planes, dividing the neck into spaces by the superficial and deep cervical fascia. The hyoid bone transects the neck anatomically into suprahyoid and infrahyoid compartments. The American Academy of Otolaryngology has published evidence-based guidelines for the workup of neck masses [1]. The neck is a complex area requiring a systematic approach for its interpretation. The checklists to be looked at before arriving at a diagnosis are lymph nodes, salivary glands, thyroid gland, vascular structures, cervical spine, aerodigestive tract, and adjacent soft tissues, including teeth with periodontal tissues and visualized sections of orbits, lung apices, and superior mediastinum [2]. CT is non-invasive and non-operator-dependent cross-sectional imaging, which allows optimal visualization of the extent and involvement of the masses with tissue-specific attenuation values [3,4]. In assessing the pulsatile neck masses, CT angiography is considered more optimal than MR angiography [5].

The clinical presentation depends on the site and origin of the mass and includes congenital, infective, inflammatory, vascular, lymph nodal, neural, and malignant etiologies [6]. With the advent of CT, anatomic differentiation of neck masses allows better communication between clinicians and radiologists [7].

METHODS

This study was conducted at GIMSR and the Alluri Sitaramaraju Academy of Medical Sciences, India. Sixty patients referred to the radiodiagnosis department in November–December 2019 were studied. Detailed information was collected. This is a non-randomized, prospective, observational study. Informed consent was obtained before the examination. An ethical clearance certificate was obtained before the study. All patients who presented with neck swelling and were willing to participate in the study were included. Exclusion criteria include patients who have undergone post-irradiation, post-surgery, and trauma history to the neck.

Statistical analysis

The data were tabulated in a Microsoft Excel worksheet. The categorical data were expressed as proportion, ratio, and rate. The following formulas were applied:

- Accuracy=(true positive+true negative)/(true positive+true negative+false positive+false negative)
- Sensitivity=true positive/(true positive+false negative);
- Specificity=true negative/(true negative+false positive);
- Positive predictive value (PPV)=true positive/(true positive+false positive);
- Negative predictive value (NPV)=true negative/(true negative+false negative)

RESULTS

Fig. 1 shows that 53.33% of patients comprised males and 46.67% comprised females in this study. The female-to-male ratio was 1:1.1.

In the present study, the most common neck space involved is visceral space in 53.3% of cases, followed by carotid space in 16.7% (Fig. 2). Benign lesions were correctly diagnosed on CT, whereas two malignant lesions were wrongly misinterpreted as benign lesions (Table 1). The

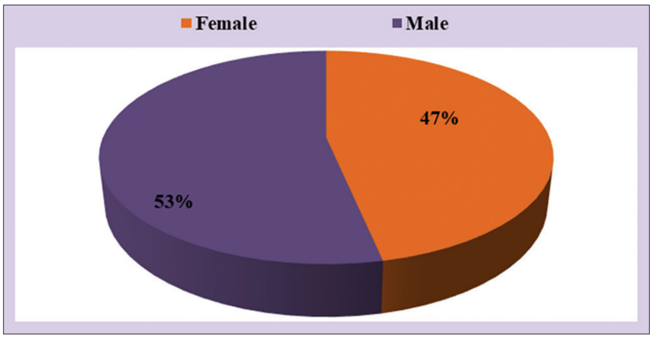

Fig. 1: Gender-wise distribution of cases

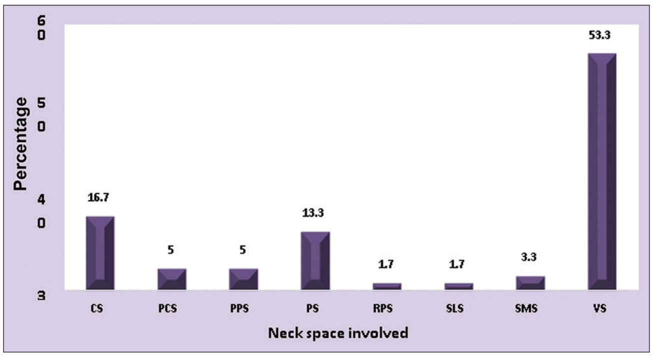

Fig. 2: Distribution of neck masses in various neck spaces. CS-carotid space (n=10), PCS-Posterior cervical space (n=3), VS-Visceral space (n=32), PPS-parapharyngeal space (n=3), SMS-Submandibular space (n=2), PS-Parotid space (n=8), RPS-Retropharyngeal space (n=1), SMS-Submental space (n=2), SLS-Sublingual space (n=1)

current study's correlation of CT results with pathological results showed that CT had a sensitivity of 86.3%, a specificity of 100%, and a PPV of 100% for identifying the type of neck mass. The NPV was 95.1%, in contrast (Table 2). The ROC curve (Fig. 3) reveals a 96.67% area under the curve. Figs. 4-6 show the CT scans of laryngeal cancer, goiter, and lymphangioma.

DISCUSSION

Cross-sectional imaging gives detailed anatomic visualization and the extent of the pathologies. The various structures in the neck are enclosed within two layers of cervical fascia. The outermost fascia is the superficial cervical fascia, composed of the loose areolar connective tissue and the platysma muscle. The structures within the deep cervical fascia include neck muscles, blood vessels, and the viscera lined by the investing fascia, pre-tracheal fascia, and prevertebral fascia of the deep cervical fascia. In addition, the neck has several lymph nodal stations, which, when enlarged, give a clue about the etiology. Necrotic lymph nodal deposits may signify either tuberculous etiology or malignancy, with the primary being localized in the neck or elsewhere in the body. Rouviere classification has simplified understanding various lymph node groups in the neck [8]. In head and neck squamous cell carcinomas, cervical lymph node metastasis plays a crucial role in the prognosis of the disease. There is almost a 50% reduction in the survival rate for head and neck squamous cell cancers in the presence of the ipsilateral, solitary cervical lymph nodes [9]. The survival rate also depends on the time of the diagnosis of head and neck cancers, as a delay in the diagnosis is a moderate risk factor for mortality [10]. The pharyngeal mucosal space (PMS) is located in the midline of the suprahyoid neck space. The retropharyngeal space is posterior to the PMS, while the parapharyngeal area is located on either side. The perivertebral, retropharyngeal, and carotid spaces run along the length of the neck and are present in both the suprahyoid and infrahyoid

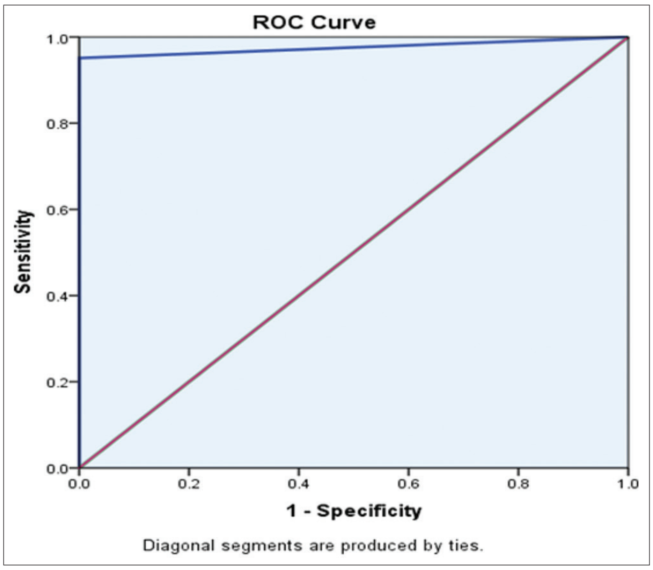

Fig. 3: ROC curve

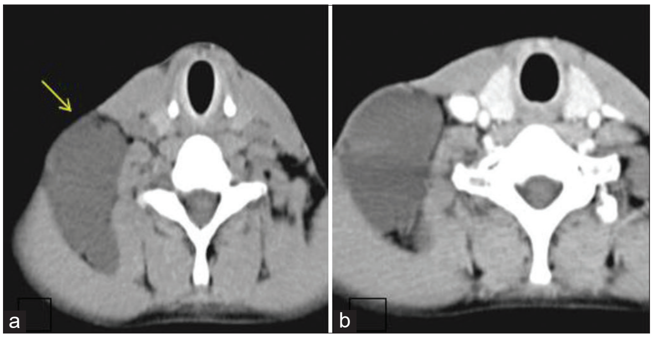

Fig. 4: Lymphangioma. (a) A non-contrast CT image shows a well-defined hypodense lesion in the right posterior cervical space. (b) Corresponding contrast CT image shows no enhancement of the lesion

Table 1: CT and pathological correlation

CT	Cyto/Histopathology		Total
	Malignant	Benign	
Malignant	19 86.36%	0 0.0%	19 31.67%
Benign	2 0.0%	39 100.0%	41 68.33%
Total	21 100.0%	39 100.0%	60 100.0%

compartments [11]. The pathological conditions in neck spaces can be divided into congenital, infective, inflammatory, and neoplastic lesions. It is essential to differentiate between intratonsillar and peritonsillar abscesses, as the former requires drainage and has a chance of recurrence [12,13]. Displacement of the parapharyngeal fat gives indirect evidence of the origin of the neck lesion [14,15]. It has a higher chance of spreading the disease between the suprahyoid neck spaces.

Masticator space is most commonly affected by odontogenic infections. It can be attributed to osteomyelitis, arteriovenous malformations, and malignancies. Cystic lesions, parotitis, benign tumors like pleomorphic adenomas and Warthin's tumors, and malignant tumors like mucoepidermoid and adenoid cystic carcinoma frequently manifest in the parotid space. Mucoepidermoid carcinoma and adenoid cystic

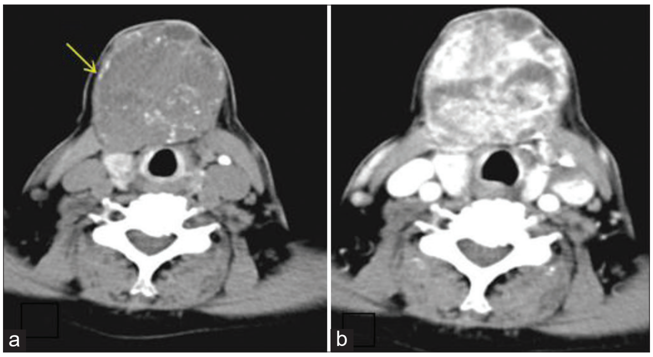

Fig. 5: Goitre. (a) Non-contrast CT image shows a large, well-defined soft tissue density lesion with calcifications in the isthmus and left lobe of the thyroid. (b) Corresponding contrast CT image shows heterogeneously enhancing lesions in the isthmus and left lobe

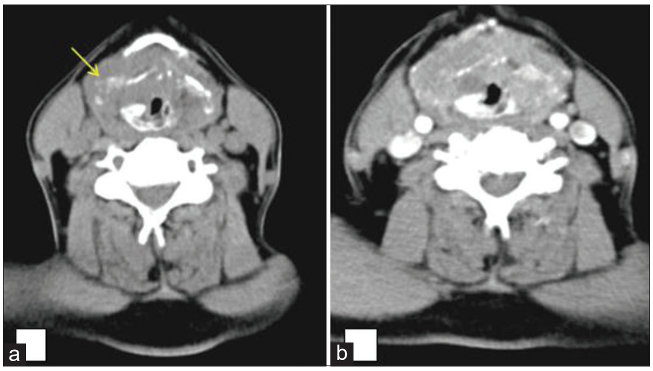

Fig. 6: Laryngeal carcinoma. (a) Non-contrast CT axial image shows ill-defined soft tissue density lesion in larynx destroying thyroid and cricoid cartilages. (b) Axial contrast CT image shows heterogeneously enhancing soft tissue density lesion in larynx causing destruction of thyroid and cricoid cartilages

Table 2: Sensitivity and specificity between CT and pathological diagnosis

CT and pathological correlation	
Sensitivity	86.36
Specificity	100
PPV	100
NPV	95.12

carcinoma are the two major salivary gland tumors that commonly develop in the parotid area [16]. Carotid space constitutes etiologies of vascular origin like jugular vein thrombophlebitis and thrombosis, arterial dissection, aneurysms and stenosis, and tumors of neural origin like schwannoma and neurofibroma. The most common head and neck paragangliomas are carotid body tumors demonstrating a "lyre sign"with avid enhancement in contrast images [17-19]. Cystic lesions in the upper anterior triangle of the neck in adults aged more than 40 years should be assessed with suspicion, as the chances of cystic malignancy, i.e., squamous cell carcinoma, are more common than brachial cysts [20]. Abscess is the most common pathology in the retropharyngeal space. PMS constitutes Thornwaldts cyst, adenoid hypertrophy, benign tumors like juvenile nasopharyngeal angiofibroma, and malignant tumors like squamous cell carcinoma, non-Hodgkins lymphoma, and nasopharyngeal rhabdomyosarcoma. Perivertebral space includes osteoporosis, pyogenic osteomyelitis, tubercular spondylitis, multiple myeloma, lymphoma, and metastasis. The posterior cervical space has metastatic squamous cell carcinoma, lymphoma, lipoma, neurofibroma, hemangioma, cystic hygroma, and lymphangioma.

Structures in the visceral space include the trachea, larynx, hypopharynx, thyroid, parathyroid glands, and paratracheal lymph nodes. The pathologies are diverse and include laryngocele, squamous cell carcinoma, chondrosarcoma, Zenker's diverticulum, tracheal stenosis, thyroid carcinoma, goiter, parathyroid adenoma, thyroglossal cyst, metastasis, and lymphoma. The presence of the thyroid capsule, lymphatic system, good vascularity, and iodine content makes the thyroid less prone to infection in the thyroid gland [21]. Epiglottitis is an acute condition that may cause respiratory distress [22]. The buccal space is composed of minor salivary glands. Therefore, the tumors associated with salivary glands, like pleomorphic adenoma, adenoid cystic carcinoma, acinic cell carcinoma, and mucoepidermoid carcinoma, are prone in this space. Sublingual and submandibular space lesions constitute ranula, Ludwig's angina, epidermoid cysts, and dermoid cysts.

Limitations and strengths

There were some limitations in this study. We could not generalize our findings to other settings because patients were analyzed only in two centers. Second, in our study, the sample size was smaller since the study period was <1 year, and the majority of the neck masses sent for CT had a high suspicion of malignancy. Our strengths include an in-depth formula-based analysis in a single study, and very few studies were conducted to determine the sensitivity and specificity of CT in neck masses.

CONCLUSION

In the present study, CT findings were correlated with pathological findings, which revealed the sensitivity of CT in detecting the nature of the neck mass to be 86.3%, with specificity and a PPV of 100%. In comparison, NPV is found to be 95.1%. Cross-sectional imaging of the CT neck provides detailed three-dimensional visualization of the lesions and their relationship with adjacent blood vessels, glands, fascia, muscles, and neck spaces. The posterior extension of the lesion is better assessed and surpasses ultrasonography. Bony involvement, either by a primary bony lesion or a direct invasion by the neck mass, can be better evaluated because of the differential attenuation values in CT.

The extent of the neck lesions' involvement with other structures gives indirect evidence of whether the mass is benign or malignant. Imaging the neck lesion using CT non-ionic contrast helps assess the characterization of the lesion.

ETHICAL APPROVAL

This study was approved by the Ethics Committee of the GITAM Institute of Medical Sciences and Research, Visakhapatnam, India (approval ID: GIMSR/Admn./Ethics/approval/IEC/S09/2019) and the Alluri Sitaramaraju Academy of Medical Sciences (approval ID: ASRAMS/Ethics/approval/IEC/M155606039).

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Nil.

AUTHOR'S CONTRIBUTIONS

All authors contribute equally to the research and manuscript preparation.

CONFLICTS OF INTEREST

None.

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