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Original Article

Radiology Section

Role of Multidetector Computed Tomography in the Detection and Characterisation of Benign and Malignant Non Lymphoid Masses of the Neck and its Concordance with Fine Needle Aspiration Cytology

NELLAIAPPAN CHELLIAH[1], THANGALAKSHMI ADAIKKALAM[2], CHIRTRARASAN PARAMAN[3], PONSHANKAR ANANDARAJA[4], PRIYA MUTHAIYAN[5], KITTU ILAMVAZHUTHI[6]

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ABSTRACT

Introduction: Computed Tomography (CT) enables the evaluation of both osseous and soft tissue details and has become an important imaging modality in the evaluation of patients presenting with a neck mass. The study was conducted to justify the usefulness of Multidetector CT (MDCT) in patients presenting with neck lesions.

Aim: To detect benign and malignant non lymphoid lesions of the neck using MDCT imaging features and compare it with Fine Needle Aspiration Cytology (FNAC).

Materials and Methods: This cross-sectional study undertaken in a Government Stanley Medical College, Chennai, India, the duration of the study, from June 2021 to May 2022. Contrast Enhanced CT (CECT) was performed with a 16 slice MDCT scanner pre and postcontrast administration. The benign and malignant lesions were evaluated by their enhancement patterns, necrosis, bony and vascular invasion and extension to adjacent neck space. The results were compared with FNAC being considered the gold standard, sensitivity and accuracy of CT was determined. The collected data was analysed with International Business Machines (IBM) Statistical Package for Social Sciences (SPSS) Version 23.0.

Results: Of the total 95 patients who were enrolled in to the study, 38 patients were females and 57 patients were males, the mean age of the subjects studied were 45.1±17.4 years, 67 cases were benign lesions and 28 cases were malignant lesions by FNA. The sensitivity and specificity of MDCT was found to be 78.6% and 95.5%, respectively with a Positive Predictive Value (PPV) of 88.0% and Negative Predictive Value (NPV) 0f 91.4%.

Conclusion: MDCT is precise in differentiating malignant from benign lesions of the neck and defining the extent of the lesions and involvement of adjacent structures.

Keywords: Enhancement patterns, Neck masses, Necrosis, Sensitivity, Specificity

INTRODUCTION

The neck used to be classified based on triangles. But, with the arrival of cross-sectional imaging, the notion of neck spaces arises. The superficial and deep cervical fascias divide the neck into 12 spaces [1,2]. CT enables evaluation of both osseous and soft tissue details and has become an important imaging modality in evaluation of patients presenting with neck mass [3]. Conventional dynamic CT scanning (slice-by-slice acquisition) is being rapidly replaced by Spiral CT in most medical centers. Spiral CT has the advantages of rapid scanning time, and less susceptibility to patient motion than conventional CT [4]. Volumetric helical data provides best results for creating 3 Dimensional (3D) and multiplanar reconstructions. Multislice-spiral CT enables near isotropic imaging in all directions for the head and neck area, leading to better identification of tumour growth and the spread of cancer to lymph nodes. Additionally, this imaging technique can take full advantage of intravenous contrast agents by obtaining the best images during the time between injection and image capture [5]. The use of two and three-dimensional displays helps visualise pathological findings in relation to the anatomical structures in the affected area. This helps to streamline the diagnostic process and allows for better communication between radiologists and clinicians. Ultimately, this leads to more efficient and accurate diagnosis and treatment planning for patients [6].

The major application of imaging is to evaluate the size and location of the tumour, as well as its infiltration into surrounding tissues and structures, such as blood vessels and nerves which helps the surgeon to best determine surgical and other therapeutic options. Imaging also plays an important role in evaluating the presence and location of lymph nodes, which is crucial in determining the stage of the disease and the appropriate treatment approach. The radiologist will use a standardised classification system to describe the location and extent of nodal involvement, which helps the other members of the healthcare team to plan treatment and monitor the response to therapy [7]. The aim of the present study was to detect benign and malignant non-lymphoid lesions of the neck using MDCT imaging features and compare it with FNAC.

MATERIALS AND METHODS

This study was a single institutional cross-sectional study undertaken in Government Stanley Medical College, Chennai from June 2021 to May 2022. Institutional Ethical Committee approval was acquired (20201219). Informed and written consent was obtained from all subjects. In paediatric patients, the consent was acquired from parents or guardians.

Based on the previous study by Gandhi N et al., in which MDCT showed 96% accuracy in diagnosing neck lesions.

Sample size calculation: The Sample size was estimated by using nMaster software Version 2.0 with an alpha of 0.05 (2-sided) and precision of 4% and a total of 92 sample size was estimated [8]. By considering the data loss three more were added and the study was done with 95 subjects.

Inclusion criteria: Patients presenting with neck swellings other than those arising from lymph nodes which are determined by ultrasonography screening, patients presenting with symptoms pertaining to the neck such as dysphagia, hoarseness of voice, odynophagia, Patients with ultrasonographically detected non lymphoid neck lesions.

Exclusion criteria: All patients with history of trauma, patients who have contraindications to contrast administration such as chronic kidney disease, high renal parameters or contrast hypersensitivity, all pregnant patients, those patients who were not willing to give consent to the study.

Study Procedure

CECT was performed with a 16-slice MDCT scanner (Toshiba Aquilion), pre and postcontrast administration. The patient was scanned in supine position. The head and neck was imaged from top of frontal sinus up to the level of aortic arch with a slice thickness of 3.75 mm, Index-3.75, Field Of View (FOV)-22 and non ionic iodinated water soluble intravenous contrast (Omnipaque) of around 100-150 ccs was given at a rate of 2-3 ccs/sec with a delay of 20 seconds. Arterial and venous phase images were obtained. Soft tissue, bone and lung windows were used for evaluation. The benign and malignant lesions were differentiated by their enhancement patterns, necrosis, bony and vascular invasion and extension to adjacent neck space. The FNAC for those lesions were done under ultrasonography guidance using 26G needle and FNAC results were considered as gold standard.

STATISTICAL ANALYSIS

The collected data was analysed with IBM SPSS Statistics for Windows, Version 23.0. (Armonk, NY: IBM Corp). To describe about the data, descriptive statistics, frequency analysis, percentage analysis were used for categorical variables and the mean & SD were used for continuous variables. The results were compared with FNAC reports. To find the efficacy of the CT to predict the FNAC outcome, the Receiver Operating Characteristics (ROC) curve was used with sensitivity, specificity, PPV, NPV & accuracy. In the above statistical tool, the probability value .05 is considered as significant level.

RESULTS

Of the total 95 patients who were enrolled in the study, 38 patients were females and 57 patients were males. The mean age of the subjects studied were 45.1±17.4 years [Table/Fig-1]. Co-morbidities were present in 49 patients {Type 2 Diabetes Mellitus-19 (38.78%), systemic hypertension-14 (28.5%), hypothyroidism-10 (20.41%), hyperthyroidism-5 (10.2%), seizure disorder-1 (2%)}. The most common presenting symptom was swelling of neck, which was present in about 91 (95.8%) of the study subjects, followed by dysphagia/odynophagia in 39 (41.1%) and hoarseness of voice in 10 (10.5%) of the study subjects. On FNAC, 67 cases were found to be benign lesions and 28 cases were found to be malignant lesions. On CECT, 82% of the malignant lesions showed heterogeneous enhancement, whereas, majority of the benign lesions were non enhancing (41.8%). Bone and vascular invasion was present in 57.1 and 14.3% of the malignant lesions respectively, whereas it is not noted in benign lesions [Table/Fig-2].

Age (years)	Frequency
11-20	9 (9.5%)
21-30	17(17.9%)
31-40	19 (20%)
41-50	18 (18.9%)
51-60	14 (14.7%)
61-70	13 (13.7%)
71-80	5 (5.3%)
Total	95

[Table/Fig-1]: Age, gender and co-morbidities distribution.
Mean±SD= 45.1±17.4

Morhological features		Frequency	
		Benign	Malignant
Enhancement patterns	Homogeneous	8 (11.9%)	3 (10.7%)
	Heterogeneous	20 (29.9%)	23 (82.1%)
	No enhancement	28 (41.8%)	2 (7.1%)
	Peripheral enhancement	11 (16.4%)	0 (0%)
Necrosis	Present	24 (35.8%)	23 (82.1%)
	Absent	43 (64.2%)	5 (17.9%)
Bony invasion	Present	0 (0%)	16 (57.1%)
	Absent	67 (100%)	12 (42.9%)
Vascular invasion	Present	0 (0%)	4 (14.3%)
	Absent	67 (100%)	24 (85.7%)
Extension to adjacent neck space	Present	10 (14.9%)	14 (50%)
	Absent	57 (85.1%)	14 (50%)

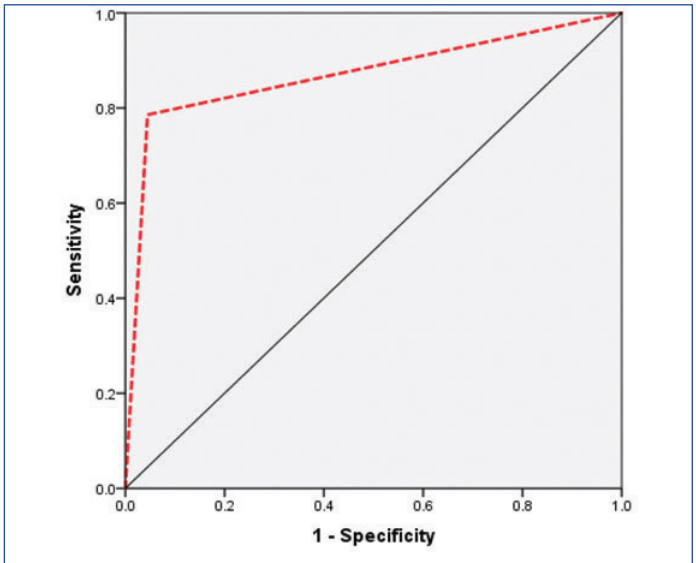
[Table/Fig-2]: Computed Tomography (CT) characteristics of benign and malignant lesions.

The ROC Curve analysis between CECT characteristics and FNAC diagnosis of benign or malignant lesion is shown below [Table/Fig-3,4]. Area=0.870, Sensitivity=78.6%, Specificity=95.5%, PPV=88.0%, NPV=91.4%, Accuracy=90.5%, p-value=0.0005.

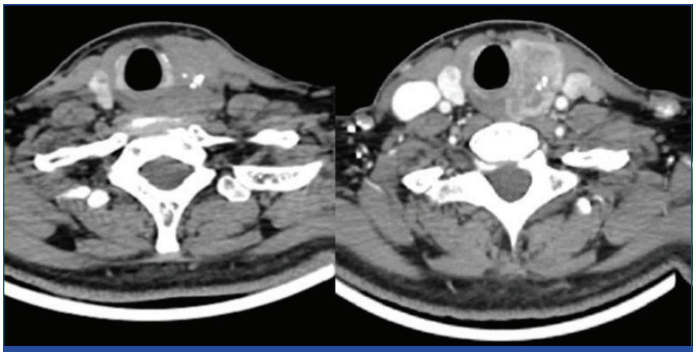
A 60-year-old male patient, presented with complaints of swelling over the anterior aspect of neck and hoarseness of voice. Non contrast and contrast-enhanced images of the neck show an ill defined heterogeneously enhancing soft tissue dense lesion arising from the left lobe of thyroid gland with multiple foci of calcifications. The lesion shows extension into the trachea-oesophageal groove and hypopharynx [Table/Fig-5]. The FNAC report was suspicious for malignancy-Bethesda V with the possibility of papillary carcinoma of the thyroid.

Area under the curve				
			Asymptotic 95% Confidence interval	
Area	Std. Error[a]	p-value	Lower bound	Upper bound
0.870	0.049	0.0005 **	0.775	0.966

[Table/Fig-3]: Receiver operating characteristic curve analysis between contrast enhanced computed tomography characteristics and fine needle aspiration cytology diagnosis of benign or malignant lesion.
**Highly Statitsical Significance at p<0.01 level



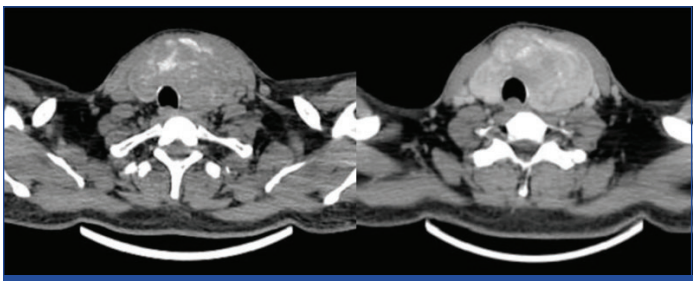
[Table/Fig-4]: Receiver operating characteristic curve.



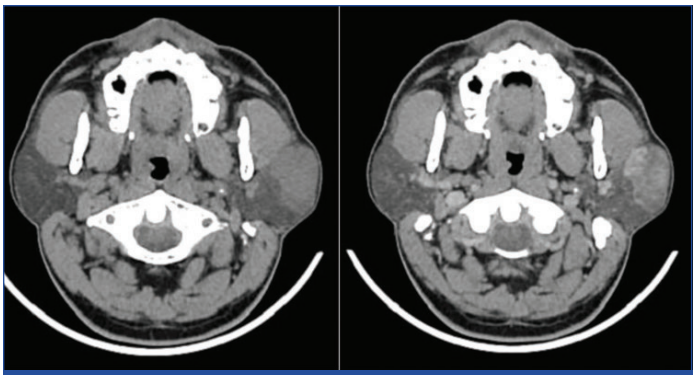
[Table/Fig-5]: Non contrast and contrast enhanced images of the neck show an ill-defined heterogeneously enhancing soft tissue dense lesion arising from the left lobe of thyroid gland with multiple foci of calcifications.

A 47-year-old male patient, who also presented with complaints of swelling over the anterior aspect of neck. Non contrast and contrast enhanced images of the neck show enlargement of isthmus and left lobe of thyroid with multiple foci of calcifications and showing multiple heterogeneously enhancing nodules. With the imaging features, it is suggestive of benign enlargement of thyroid and the FNAC report also correlated well with the imaging findinds, which was multinodular goiter [Table/Fig-6].

A 38-year-old female patient, who presented with complaints of swelling over the left preauricular region. Non contrast and CECT images show a well-defined heterogeneously enhancing soft tissue dense lesion in left parotid gland. The imaging findings are suggestive of a benign lesion and the FNAC report was pleomorphic adenoma [Table/Fig-7].



[Table/Fig-6]: Non contrast and contrast enhanced images of the neck show enlargement of isthmus and left lobe of thyroid with multiple foci of calcifications and multiple heterogeneously enhancing nodules with no obvious involvement of adjacent structures.



[Table/Fig-7]: Non contrast and contrast enhanced images show a well-defined heterogeneously enhancing soft tissue dense lesion in the left parotid gland.

DISCUSSION

In this study, the computed tomography imaging characteristics of benign and malignant tumours of the neck was compared with FNAC. Although the final histopathology report after surgery is the gold standard in arriving at a definitive diagnosis of a benign and malignant lesion, FNAC has reasonable sensitivity and good specificity in differentiating benign and malignant masses and it also has advantages of being less invasive, easily accessible and cost effective. FNAC is almost always the initial mode of investigation in neck masses with imaging features of malignancy. FNAC also helps in diagnosis of inflammatory, infective and degenerative lesions in addition to neoplastic lesions [9].

Regarding enhancement patterns, 41.8% of the beign lesions showed no enhancement, whereas, 82.1% of the malignant lesions showed predominant heterogeneous enhancement. This correlated well with the study done by van Tran NA et al., which showed that majority of the benign lesions showed no enhancement and majority of the malignant lesions showed enhancement on contrast enhanced images [10]. Necrosis was present in 82.1% of the malignant lesions. In a study by Eskey C et al., 91 states that necrosis is more frequently seen in malignant lesions [11]. Bony involvement was seen in 57.1% of the malignant lesions and none of the benign lesions. In a study done by Imaizumi A et al., it has been shown that MDCT with multiplanar reformations and thin cuts (0.5 mm) has higher specificity in detecting subtle cortical erosions, as bony invasion is an important factor in determining the malignant nature of the tumour [12]. Extension into the adjacent space was seen in 50% of malignant lesions and in 14.9% cases of benign lesions. A study by Tran NA et al., states that malignant lesions tend to be more infiltrative and extend beyond fat or fascial planes [10]. The sensitivity of MDCT for evaluating and differentiating the benign and malignant lesions of the neck in comparison to FNAC was 78.6%, and specificity was 95.5%, with a PPV of 88%. This correlated with the findings of the study done by Gupta P et al., which assessed the role of multidetector spiral CT in the evaluation of neck masses. The accuracy of multi-slice CT in predicting the benign or malignant mass and its extent was observed to be very high (97% and l00%, respectively). [Table/Fig-8] depicts the accuracy values of the present study vs published studies [13,14]. In all cases, the extent of the pathology, the local or contiguous spread, and vascular involvement predicted by multi-slice CT examination supported well with the surgical findings [15].

Parameter	Present study	Kaur S et al., (2020) [13]	Siddiqua UI et al., (2018) [14]
Sensitivity	78.6%	95.83%	94.6%
Specificity	95.5%	96.3%	95%
Positive Predictive Value (PPV)	88%	92%	97.2%
Negative Predictive Value (NPV)	91.4%	98.1%	90.5%
Accuracy	90.5%	96.15%	94.7%

[Table/Fig-8]: Results of the present study compared to previous similar articles [13,14].

Limitation(s)

The major limitation of the present study was that the study included all non lymphoid neck mass lesions irrespective of their diagnoses and histopathological variety. Present study did not include the individual lesions, which are inherent to their respective neck spaces, and thus a large-scale study with greater logistics support and adequate randomisation is recommended with the involvement of other departments.

CONCLUSION(S)

Multidetector CT is precise in differentiating malignant from benign lesions of the neck. This plays an important role in the planning of surgical excision and also in deciding portals for radiotherapy. MDCT also provides excellent bony details and helps in the identification of bone involvement, which is an important feature of malignancy.

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PARTICULARS OF CONTRIBUTORS:
1. Professor, Department of Radiodiagnosis, Government Stanley Medical College and Hospital, Chennai, Tamil Nadu, India.
2. Assistant Professor, Department of Radiodiagnosis, Barnard Institute of Radiology, Madras Medical College and Hospital, Chennai, Tamil Nadu, India.
3. Professor, Department of Radiodiagnosis, Government Stanley Medical College and Hospital, Chennai, Tamil Nadu, India.
4. Assistant Professor, Department of Radiodiagnosis, Government Stanley Medical College and Hospital, Chennai, Tamil Nadu, India.
5. Assistant Professor, Department of Radiodiagnosis, Government Stanley Medical College and Hospital, Chennai, Tamil Nadu, India.
6. Junior Resident, Department of Radiodiagnosis, Government Stanley Medical College and Hospital, Chennai, Tamil Nadu, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Ponshankar Anandaraja,
Assistant Professor, Department of Radiodiagnosis, Government Stanley Medical College and Hospital, Old Jail Road, Old Washer Manpet, Chennai-600001, Tamil Nadu, India.
E-mail: ponshankara@gmail.com

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