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## Diagnostic efficacy of multi-detector computed tomography in delineation of neck masses

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### Abstract

**Background:** MDCT with its speed, use of thinner collimation, multiplanar reformation technology and easy availability makes it the diagnostic modality of choice.

**Objectives:** to assess the role of MDCT in detection, characterization and extension of neck masses.

**Method:** 40 patients with suspected neck lesions were subjected to CECT in our institution and the images were analyzed on plain scan and after the administration of non-ionic intravenous contrast agent. The lesions were studied with respect to enhancement pattern, local invasion, bony involvement and vascular invasion.

**Results:** There were 15 malignant lesions and 25 benign lesions in our study. The imaging diagnosis of malignant and benign lesions was confirmed on histopathology. We had one false negative where one case of mandibular osteosarcoma was wrongly interpreted as osteomyelitis. MDCT had an overall accuracy of 97.5%.

**Conclusion:** MDCT can be a very valuable tool in localizing and characterizing the neck lesions and it is the diagnostic modality of choice. It can aid in the diagnosis of neck lesions at the earliest and help in determining the accurate modality of treatment.

**Keywords:** Neck lesions, CT, MDCT, malignant, benign

### Introduction

A mass lesion in the neck can be a diagnostic challenge in a patient of any age. By the introduction of cross sectional imaging a new dimension in evaluation of neck lesions has evolved. Traditionally the neck used to be classified based on triangles<sup>[1]</sup>.

But with the advent of cross sectional imaging the concept of neck spaces has come into picture. The neck is divided into twelve spaces by the superficial and deep cervical fascia<sup>[1]</sup>.

By allocation of a tumor to a certain space the number of differential diagnosis drops dramatically due to the fact that in different compartments different types of soft tissues occur<sup>[2]</sup>. It is important to differentiate a malignant neck lesion from a benign lesion.

The ease of obtaining CT scans and rapid scan acquisition are its advantages. The transaxial orientation of CT planes is particularly useful in certain locations such as the pterygopalatine fossa. As technology advances in the use of CT, its application in head and neck lesions has increased<sup>[3]</sup>.

CT with its unique capacity to display osseous and soft tissue details has become an indispensable tool in evaluation of patients with neck mass<sup>[4]</sup>. Spiral CT permits rapid scanning of large volumes of tissue during quiet respiration. It is less susceptible to patient motion than conventional CT<sup>[5]</sup>. Volumetric helical data permits optimal multiplanar and 3D reconstructions. Spiral-CT is standard for imaging neck tumours. Multislice-spiral-CT allows almost isotropic imaging of the head and neck region and improves the assessment of tumour spread and lymph node metastases in arbitrary oblique planes. MSCT is especially advantageous in defining the critical relationships of tumour and lymph node metastases and for functional imaging of the hypopharynx and larynx not only in the transverse plane but also in the coronal plane. The rapid acquisition results in volumetric data set, reconstructed to a stack of thin and overlapping native images, thus reducing partial volume averaging and motion artefacts. Furthermore full advantage of intravenous contrast agent is accomplished by optimal imaging between the injection and image acquisition<sup>[6]</sup>.

Thus, the radiologist can point out to the clinician the pathological findings by some essential images without having to demonstrate all axial slices<sup>[7]</sup>.

The main reason for head and neck imaging is to evaluate the true extent of disease, to best determine surgical and therapeutic options. This process includes evaluation of the size, location, and extent of tumor infiltration into surrounding vascular and visceral structures. Second, nodal staging should be assessed in an effort to increase the number of abnormal nodes detected by physical examination and, more important, to precisely define their location by a standard classification system that can be understood and consistently applied by the radiologist, surgeon, radiation oncologist, and pathologist. Although CT and MRI are both well suited to evaluation of the deep spaces and sub-mucosal spaces of the head and neck, each has some limitations. MRI has the advantages of higher soft tissue contrast resolution, the lack of iodine-based contrast agents, and high sensitivity for perineural and intracranial disease. The disadvantages of MRI include lower patient tolerance, contraindications in pacemakers and certain other implanted metallic devices, and artifacts related to multiple causes, not the least of which is motion. CT is fast, well tolerated, and readily available but has lower contrast resolution and requires iodinated contrast and ionizing radiations<sup>[8]</sup>. Hence this study is an effort to assess the role of MDCT in detection, characterization and extension of neck masses.

**Methods**

The present clinical study was conducted in hospitals attached to Department of Radio-diagnosis, viz, J.J.M. Medical College and Bapuji Hospital, Davangere. During 24 months period (September 2015 to August 2017), a total of 40 cases of neck lesions were evaluated at the Department of Radio-diagnosis on patients presenting with neck swelling or on patients in whom a neck mass was picked up on ultrasound study. Patients were evaluated with Multidetector CT (Toshiba Activion 16 slice multidetector CT). Provisional diagnosis was given and was correlated with histopathological and postoperative diagnosis.

**Sample size determination**

The sample size was calculated for 39, based on alpha significance level of 0.05, effect size of 0.45 and power of 80%. The sample size was computed using with G power software v.3.1.9.2.

**Method of collection of data**

A prospective study was conducted over a period of 2years (September 2015 to August 2017) on 40 patients with clinically suspected neck lesions or patients who were diagnosed to have neck lesion on ultrasound and were referred to CT for further characterisation. The patients presented with symptoms of palpable neck mass and neck pain. Patients were evaluated with Multidetector CT (Toshiba Activion 16). A provisional diagnosis was made after CT scan and these findings were correlated with histopathology/ surgical findings as applicable.

**Inclusion criteria**

1. Patients presenting with palpable neck masses.
2. Neck masses detected on ultrasound.
3. Patients presenting with symptoms related to neck area

**Exclusion criteria**

1. All patients with history of trauma, will be excluded from the study.
2. Patients who do not provide a valid consent for the procedure.

3. Pregnant women will be excluded from the study due to the risk of radiation hazard to the growing fetus.
4. Patients with altered renal parameters will be excluded from the study as intravenous contrast agent cannot be administered in such patients.
5. Patients who are allergic to intravenous contrast agent will be excluded from the study.

**Technique of the study**

Patients were kept nil orally 4 hours prior to CT scan to avoid complications while administrating contrast medium. The risk of contrast administration were explained to the patient and consent was taken prior to the contrast study. Routine lateral topogram of the neck was taken in all patients in supine position with head in extended position. Axial plain sections were taken using 5mm sections from the base of the skull to thoracic inlet, and reconstructed to 1mm sections. In all patients plain study was followed by contrast study using 5mm sections and reconstructions to 1mm thinner sections. Contrast study was done using 50- 60 ml (1ml/ kg body weight) of 300mg/ml of non-ionic, iodinated IV contrast agent (ultravist) and images were taken. Post processing reconstructions were done using 1mm reconstructions and in sagittal and coronal planes. Newer techniques such as Maximum intensity projections and minimum intensity projections were done as and when necessary.

Scans were later reviewed in appropriate windows ie, mediastinum window and bone window.

The pathological lesions were evaluated with respect to the size of the lesion, location of the lesion, enhancement pattern, presence of calcification, presence of necrosis, presence of fat, extension into adjacent structures and presence or absence of venous thrombosis and bony involvement.

**Statistical analysis:** The data collected will be entered into excel spread sheet and analyzed using the Statistical Package for Social Sciences (SPSS) version 22. Descriptive statistics with frequency, percentage will be taken. Statistical significance is considered at  $p < 0.05$  (confidence interval of 95%). Necessary Statistical tests will be dealt at the time of analysis accordingly.

**Result:** In the present study maximum percentage of patients were in the age group of 51 60years (25%) followed by 61-70 years (20%). The present study show male preponderance (55%) with male to female ratio of 1.22:1. Most common benign neck mass was in the age group of 21-30 years and 31 – 40 years. The current study shows higher incidence of benign neck mass among females with a female to male ratio of 1.08:1. Table 1.

**Table 1:** Age and gender distribution of benign lesions (n=25)

Age group (yrs)	Female		Male		Total	
	No	%	No	%	No	%
< 10	2	15.4%	2	16.7%	4	16%
11 – 20	0	0%	2	16.7%	2	8%
21 – 30	4	30.7%	1	8.3%	5	20%
31 – 40	2	15.4%	3	25%	5	20%
41 – 50	2	15.4%	0	0%	2	8%
51 – 60	2	15.4%	2	16.7%	4	16%
61 – 70	1	7.7%	1	8.3%	2	8%
> 71	0	0%	1	8.3%	1	4%
<b>Total</b>	<b>13</b>		<b>12</b>		<b>25</b>	

The current study shows higher incidence of malignant lesions between 51-60 years and 61-70 years. Higher

incidence among males was noted with a male to female ratio of 2:1. Table 2.

**Table 2:** Age and gender distribution of malignant lesions (n=15)

Age group (yrs)	Female		Male		Total	
	No	%	No	%	No	%
< 10	0	0%	0	0%	0	0%
11 – 20	0	0%	0	0%	0	0%
21 – 30	0	0%	0	0%	0	0%
31 – 40	1	20%	0	0%	1	6.6%
41 – 50	0	0%	1	10%	1	6.6%
51 – 60	2	40%	4	40%	6	40%
61 – 70	1	20%	5	50%	6	40%
> 71	1	20%	0	0%	1	6.6%
<b>Total</b>	<b>5</b>		<b>10</b>		<b>15</b>	

Out of 40 cases studied 25 (62.5%) were of benign etiology and 15 (37.5%) were of malignant etiology.

Most( 88 %) of the benign lesions of the neck were below the age of 60 years except for a case of parapharyngeal and retropharyngeal abscess which were diagnosed in a 70 year old female and 65 year old male respectively and a case of sub mandibular tubercular lymph node mass which was

diagnosed in 85 year old male.

Most (80%) of the malignant lesions of the head and neck region in this series were above the age of 50 years except for a case of papillary carcinoma of thyroid which was diagnosed in a 33 year old female and a case of malignant lymph node which was diagnosed in a 48 year old male. Table 3.

**Table 3:** Distribution of neck lesions according to age (n=40)

Neck spaces	Diagnosis	Age (years)								Total	
		0-10	11-20	21-30	31-40	41-50	51-60	61-70	>70	No	%
Masticator	Abscess	-	-	-	1	-	1	-	-	4	10
	Benign mandibular osteomyelitis	-	-	-	-	-	1	-	-		
	Malignant mandibular osteosarcoma	-	-	-	-	-	1	-	-		
Carotid	Benign lymph node	-	-	-	-	-	1	-	-	1	2.5
Parotid	Haemangioma	1	-	-	-	-	-	-	-	3	7.5
	Lymphangioma	2	-	-	-	-	-	-	-		
Pharyngeal mucosal space	Malignant nasopharyngeal carcinoma	-	-	-	-	-	2	-	-	3	7.5
	Benign adenoids	-	1	-	-	-	-	-	-		
Retropharyngeal space	Benign abscess	-	-	-	-	-	-	1	-	1	2.5
Posterior cervical space	Lymphangioma	-	-	1	-	-	-	-	-	1	2.5
Submandibular/sublingual	Dermoid cyst	-	-	-	-	1	-	-	-	5	12.5
	Benign lymphnode	-	1	-	-	-	-	-	1		
	Malignant lymph node	-	-	-	-	1	-	-	-		
Visceral space	Lymphangioma	1	-	-	-	-	-	-	-	16	40
	Thyroglossal cyst	-	-	-	1	-	-	-	-		
	Malignant laryngeal carcinoma	-	-	-	-	-	1	3	-		
	Malignant hypopharyngeal carcinoma	-	-	-	-	-	1	3	-		
	Malignant papillary carcinoma thyroid	-	-	-	1	-	-	-	1		
	Adenomatous thyroid nodule	-	-	1	1	-	-	-	-		
	Thyroiditis	-	-	1	-	1	-	-	-		
	Colloid cyst	-	-	1	-	-	-	-	-		
Parapharyngeal space	Abscess	-	-	1	-	-	-	1	-	6	15
	Malignant lymphnodes	-	-	-	-	-	-	1	-		
	Benign lymphnode	-	-	-	2	-	1	-	-		

In the present study malignant lesions prevailed among male population with a male to female ratio of 2:1. Relatively

higher incidence of benign lesions among females was noted with a female to male ratio of 1.08: 1. Table 4

**Table 4:** Distribution of neck lesions according to gender (n=40)

Etiology	Total	Male	Female
Papillary carcinoma thyroid	2	0	2
Benign lymphnode	6	5	1
Hypopharyngeal carcinoma	4	4	0
Lymphangioma	4	2	2
Pharyngeal mucosal carcinoma	2	2	0
Thyroglossal cyst	1	0	1
Dermoid cyst	1	0	1
Colloid cyst	1	0	1

Thyroiditis	2	0	2
Laryngeal carcinoma	4	3	1
Adenomatous thyroid nodule	2	0	2
Masseteric abscess	2	2	0
Parapharyngeal abscess	2	1	1
Adenoid hypertrophy	1	1	0
Mandibular osteomyelitis	1	0	1
Hemangioma	1	0	1
Mandibular osteosarcoma	1	0	1
Retropharyngeal abscess	1	1	0
Malignant lymph node	2	1	1
Total	40	22	18

Most common malignant lesions in this series were laryngeal carcinoma and hypopharyngeal carcinoma. Table 5.

**Table 5:** Among the malignant lesions (n=28)

Lesion	Number	Percentage
Larynx	4	26.66%
Thyroid gland	2	13.33%
Hypopharynx	4	26.66%
Lymphnodes	2	13.33%
Nasopharynx	2	13.33%
Mandible	1	6.66%
<b>Total</b>	<b>15</b>	

## Discussion

The computed tomographic scans of 40 patients who were found to have neck lesions were analyzed with available similar studies. Out of 40 cases studied 25 (62.5%) were of benign etiology and 15 (37.5%) were of malignant etiology. The rapid growth and early severe symptoms of malignant lesions make the patients to seek medical help earlier. Most (88 %) of the benign lesions of the neck region were below the age of 60 years. Most (80%) of the malignant lesions of the neck region in this series were above the age of 50 years. This was comparable to a study conducted by Otto RA *et al.* [1]

In the present study male predominance of malignant lesions were detected with a male to female ratio of 2:1. Most of the malignant lesions of the neck were found among the males. This could be attributed to the smoking and alcohol habits which are the risk factors for head and neck malignancies. This was comparable to the studies conducted by Abhinandan Bhattacharjee (2004) [10].

The most common neck lesion presented by patients in our study was lymph node. Out of 8 cases (20%) 6 were benign lymph-nodes (75%) and 2 were malignant lymph nodes. This was comparable to a case series done by Reede DL, *et al.* (1982) [11] in which the most common neck lesion encountered was lymph-node mass.

The most common malignant lesions in the neck in the present study were laryngeal carcinoma (26.66%) and hypopharyngeal carcinoma (26.66 %) which was comparable to a study conducted by Hasan Altumbabic *et al.* (2008) [12] where laryngeal cancers were most common (26.1%) followed by cancers of oropharyngeal region.

The most common space involved in the present study was visceral space (40%) followed by parapharyngeal space (15%). This could be attributed to the higher incidence of laryngeal carcinomas and lymph nodes in these spaces in the present study.

Bony involvement was seen in 33.3% of the malignant lesions and in 4% of benign lesions.

The benign lesions (mandibular osteomyelitis) caused bony expansion and remodeling rather than bony destruction and erosion. Whereas the malignant lesions (hypopharyngeal carcinoma, mandibular osteosarcoma and nasopharyngeal carcinoma) caused bony erosion.

In this present study total of 5 deep neck space abscesses (1 retropharyngeal, 2 parapharyngeal and 2 masticator space) were encountered which were accurately diagnosed by CT with a sensitivity and specificity of 100 %. This was comparable to a study by Freling *et al.* [13] who conducted CECT examinations of patients with clinical suspicion of a deep neck abscess has reported a positive predictive value (PPV) for the presence of an abscess was 82% and a negative predictive value (prediction of no abscess) was 100%.

Among the deep neck space infections 80% were among males which was comparable to a study conducted by Wang LF. [14] On space infection of the head and neck and concluded that there is male preponderance.

In the present study, out of a total of 40 cases, 4 cases were localized to have masticator space involvement. Out the 4 cases 2 were masticator space abscesses, 1 case of mandibular osteomyelitis and 1 case of mandibular osteosarcoma. The sensitivity and specificity of masticator space lesions were 100% and 100% respectively and negative predictive value is 97.29 % and accuracy of 97.5 %. A case of osteosarcoma was wrongly identified as osteomyelitis.

In a study conducted by Bentz BG, *et al.* [15] 324 consecutive cases of salivary gland masses were found, out of which 192 were hemangiomas (59.2%), 89 were lymphangiomas (27.5%), and 43 (13.3%) were solid masses. 61% of the masses were found in the parotid region.

In the present study 3 cases of pharyngeal mucosal lesions were diagnosed. A case of adenoid hypertrophy and 2 cases of nasopharyngeal carcinoma. CT could accurately diagnose the cases in all 3 patients with sensitivity and specificity of 100%.

In a study by Malard O, *et al.* [16] in evaluating the useful fullness of computed tomography in oropharyngeal cancers they found that Sensitivity of CT for tumor extension was 82%, predictive value for bone involvement 67%. In their study they found that Clinical examination was poor in predicting the presence (54%) or absence (56%) of node involvement. Sensitivity of CT was 80%, specificity 71%, positive predictive value 67%, and negative 83%. In our study higher sensitivity and specificity could be attributed to lower sample size.

In the present study 8 patients presented with lymph node swellings (4 parapharyngeal, 3 sub-mandibular and 1 case of carotid space node) out of which 2 were malignant and 6 were benign. Based on size criteria, central necrotic area and



enhancement pattern CT correctly differentiated benign and malignant lymph-nodes with 100% sensitivity and specificity and an accuracy of 100% which were comparable to the studies conducted by Shingaki S. *et al.*<sup>[17]</sup> In the study by Steinkamp H J *et al.*<sup>[18]</sup> on cervical lymph-node metastasis. Spiral CT had an accuracy of 96% and they concluded that spiral CT is highly accurate to differentiate the metastatic lymph node from inflammatory nodes.

### Conclusion

It was concluded that Multidetector Computed Tomography of the neck has improved the localization, characterization and staging of neck lesions. Thin slice high resolution image acquisition allows high quality multiplanar reconstructions with superior evaluation of bony structures and calcifications. CT scan provides accurate delineation of disease, thus helping in reliable pre-operative diagnosis and post treatment follow up.

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### Declarations

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**Conflict of interest:** None

**Ethical approval:** Permission for the study was obtained from the College authorities prior to commencement.

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