Evaluation of Lesions in Neck Spaces by Contrast Enhanced Computed Tomography

Dr. G. Yuvabalakumaran, Dr. Raja Ram Kommisetti, Dr. Vinoth Kumar, Dr. R. M. Sidhesh, Dr. R. Sathiyanarayanan

MD (Radiodiagnosis), Professor, Vinayaka Missions Kirupananda Variyar Medical College and Hospitals, Vinayaka Missions Research Foundation (DU), Salem.

MD (Radiology Resident), Vinayaka Missions Kirupananda Variyar Medical College and Hospitals, Vinayaka Missions Research Foundation (DU), Salem.

MD (Radiodiagnosis), Professor, Vinayaka Missions Kirupananda Variyar Medical College and Hospitals, Vinayaka Missions Research Foundation (DU), Salem.

MD (Radiodiagnosis), Associate Professor, Vinayaka Missions Kirupananda Variyar Medical College and Hospitals, Vinayaka Missions Research Foundation (DU), Salem.

Contributing Author: Dr. R. Sathiyanarayanan,
rajaram4105dr@gmail.com

ABSTRACT

Introduction

Lesions involving the neck are a common cause for referral to general medicine and general surgery outpatient departments. The benign and malignant lesions must be differentiated by cross sectional imaging for a proper treatment and follow-up. With a high scanning speed, multiplanar reformatting technology, thinner collimation and easy availability, CECT can be relied upon as an initial modality in characterization and localization of lesions of neck. Many studies have been published mentioning the role of CT in studying lesions of neck, but very few mentioned Contrast enhanced CT. Hence, this study is aimed at assessing the characterization and localization of neck lesions by CECT.

Aims and Objectives

To identify the role of Contrast Enhanced Computed Tomography in evaluation of lesions of neck spaces with respect to:

a) Characterization and localization of lesions of neck spaces with respect to anatomical plane delineation, involvement of bone and extension to adjacent structures.
b) To correlate CECT findings with final diagnosis

Materials and Methods

CECT was performed in our institution on 50 patients with suspicious lesions in the neck and the plain images and post intravenous contrast images were studied. The pattern of enhancement, adjacent space invasion, involvement of bone and venous thrombosis were studied.

Results

Malignant lesions were 28 in number while benign lesions were 22 in number. The radiological diagnoses were confirmed on histopathology. A false positive finding was recorded in which an inaccurate diagnosis as tumour recurrence was made for a case of post radiation necrosis. A false negative finding was recorded in which a wrong diagnosis as benign lesion was made for a case of buccal carcinoma.

Conclusion

CECT is a reliable modality for the characterization and localization of lesions in neck spaces and guides in determining the treatment modality.

Key words – CECT, Neck lesions, Benign lesions, Malignant lesions, CT

ARTICLE

Evaluation of Lesions in Neck Spaces by Contrast Enhanced Computed Tomography

Since Roentgen's discovery of the X-ray in 1895, the invention of computerized tomography (CT) has revolutionized medical diagnostic techniques. Cross sectional imaging has added a new dimension in evaluation of lesions of neck. Various lesions of head and neck such as lesions of nasopharynx, larynx, neck areas and skull base can be evaluated by CT[1] .CT has brought about the advantage of evaluating these lesions in the horizontal plane.

The advantage of CT is its ability to acquire images rapidly and the ease of performing the scan. The application of CT in evaluation of head and neck lesions has grown with the advance in technology.[2]

Neck is the region located between skull base and the inlet of thorax and is shaped like a conical space. The hyoid bone divides it into a suprahyoid part and an infrahyoid part.[3]

Traditional classifications have divided the neck into triangles. Cross sectional imaging has helped to classify the neck into neck spaces. Twelve spaces can be identified in the neck divided by the superficial fascia and the deep fascia.[4]

The ability of CT to show bony as well as soft tissue details has made it an important instrument in diagnosis of neck masses.[5]

Spiral-CT is the preferred modality for imaging of tumors of the neck. Midline crossing small tumors of the palate or the base of the tongue can be assessed with the help of coronal reconstructions[6]. The assessment of tumour and metastases of lymph nodes and functional imaging of the larynx and the hypopharynx can be defined by MSCT in the transverse and coronal planes. The volumetric data set acquired rapidly can be reconstructed into thin, overlapping stack of images, which minimizes motion artifacts and partial volume averaging[7]. Intravenous contrast imaging is made more efficient by rapid imaging between the time of injection and the time of acquisition of image.[8]

MPRs provide additional planes for evaluation in the whole extent of the head and neck. SSDs helps in evaluation of bone destruction. For extensive tumors requiring multi-specialty surgery, three-dimensional reformations with color-coding are helpful.[9]

MATERIALS AND METHODS

A cross-sectional study was conducted over a period of 16 months (February 2021 to May 2022) on 50 patients with suspicious neck mass on clinical examination or patients diagnosed with neck lesions on ultrasound examination and were referred to CECT. Data for the study was obtained from patients attending department of Radiodiagnosis, Vinayaka Missions Kirupananda Variyar Medical College and Hospital, Salem.

The common symptoms were neck pain and palpable neck mass. Patients were evaluated with CECT (GE Revolution ACTs). A provisional diagnosis for the mass was made after CECT which was correlated with histopathological findings/ surgical findings as applicable. Inclusion criteria included 1) Patients with swelling in the neck, 2) Patients with neck related symptoms, 3) Patients with suspicious mass in the neck, 4) Patients with detected neck lesion on ultrasound. Exclusion criteria included 1) Trauma cases, 2) Patients with neck lesion, but contraindicated for contrast administration due to causes such as high renal parameters or contrast hypersensitivity, 3) Moribund patients

Patients were maintained nil per oral 4 hours prior to CECT scan to avoid complications while contrast administration. Risks associated with administration of contrast were explained to patient and prior consent was taken. Lateral topogram of neck in supine position with extension of head was taken. Sections in axial plane were taken using 5 mm thick sections from skull base to inlet of thorax, and reconstructed to sections of thickness 2.5 mm. Plain CT was followed by performing contrast CT using 4 mm thick sections reconstructed to

sections of thickness 1.5 mm. Contrast CT was performed using 50 ml of intravenous contrast agent (iohexol), and images were taken in arterial phase and venous phase.

Reconstructions post processing were performed using 1.5 mm thick reconstructions. Latest methods such as maximum and minimum intensity projections were performed as per necessity. Mediastinal, laryngeal and bone window were used for viewing scans.

The lesions were examined with respect to location, size, enhancement pattern of the lesion, presence of fat, calcifications, extension into surrounding structures and presence or absence of thrombus in veins and bone involvement.

STATISTICAL ANALYSIS

Descriptive statistical analysis was performed in the current study. Results pertaining to continuous measurements have been presented on mean =/- standard deviation (min-max) while results pertaining to categorical measurements have been presented in numbers (%). A 5% level of significance was considered significant. Chi square test/ Fischer exact test were used to identify the significance of correlation of findings in CT scan with the final diagnosis. Sensitivity, specificity, positive predictive value, negative predictive value and accuracy have been calculated to identify the significance of correlation of findings in CT scan with the final diagnosis.

1. Chi square test – where o is the observed frequency and e is the expected frequency.
2. Fischer exact test.
3. Diagnostic statistics

RESULTS

Majority of patients in the current study belonged to the age group of 61-70 years followed by 51-60 years (Table 1).

The current study shows male preponderance with a ratio of 3:2 between males and females (Table 2).

Benign lesions of neck were most common in the age group of 21-30 years. The present study recorded a higher incidence of benign neck lesions in females, with a ratio of 1.44:1 between females and males.

Malignant lesions of neck were most common in the age group of 61-70 years. The present study recorded a higher incidence of benign neck lesions in males, with a ratio of 3:1 between females and males.

22 (44%) cases had benign lesions while 28 (56%) cases had malignant lesions, out of total of 50 cases. Most (76.5%) benign tumours were noted in age groups below 50 years (Table 3). Among malignant lesions, most common were metastatic lymph nodes while second most common were laryngeal carcinoma (Fig 1. and Fig 2.).

Parapharyngeal and visceral space were most commonly involved spaces (Table 4), with a male preponderance (Fig 3. and Fig 4.). The male to female ratio was 2:1.

In the current study, 48 cases out of 50 were accurately diagnosed by contrast enhanced computed tomography, with an accuracy of 96% (Table 5).

A false positive finding was recorded in which an inaccurate diagnosis as tumour recurrence was made for a case of post radiation necrosis. A false negative finding was recorded in which a wrong diagnosis as benign lesion was made for a case of buccal carcinoma.

Table 1: DEMOGRAPHIC PROFILE- DISTRIBUTION ACCORDING TO AGE (n=50)

AGE (yrs)	FREQUENCY	PERCENTAGE
<10	3	6%
11-20	3	6%
21-30	7	14%
31-40	6	12%
41-50	7	14%
51-60	9	18%
61-70	10	20%
>70	5	10%
TOTAL	50	100%

Table 2: Distribution of neck lesions according to gender

ETIOLOGY	TOTAL	MALE	FEMALE
Masseteric hemangioma	1	0	1
Lymph nodes	12	8	4
Nasopharyngeal angiofibroma	1	1	0
Nasopharyngeal carcinoma	1	1	0
Trigeminal schwannoma	1	0	1
Maxillary carcinoma	1	1	0
Mandibular AVM	1	0	1
Buccal carcinoma	4	1	3
Hemangioma buccal space	1	0	1
Vagal schwannoma	2	1	1
Paraganglioma	1	0	1
Lymphangioma	2	1	1
Branchial cleft cyst	2	0	2
Retropharyngeal abscess	1	0	1
Submandibular neoplasm	1	1	0
Submandibular abscess	1	1	0
Tonsillar carcinoma	1	1	0
Base of tongue carcinoma	1	1	0
Laryngeal carcinoma	5	5	0
Adenoids	1	1	0
Visceral space abscess	2	2	0
Prevertebral abscess	2	1	1
Parathyroid adenoma	1	0	1
Adenoid cystic carcinoma	1	1	0
Intraparotid lymph node	1	1	0
Pleomorphic adenoma	1	1	0
Post radiation necrosis	1	0	1
TOTAL	50	30	20

Table 3: Features of neck lesions in ct

MALIGNANT LESIONS	MALIGNANT LESIONS									
	Enhancement		Necrosis		Bone invasion		Vessel invasion		Adjacent space	
	Homogenous	Heterogenous	Negative	Positive	Absent	Present	Absent	Present	Absent	Present
Laryngeal carcinoma	1	4	1	4	3	2	5	0	2	3
Buccal carcinoma	1	3	2	2	3	1	4	0	4	0
Nasopharyngeal ca	0	1	0	1	0	1	1	0	0	1
Submandibular neoplasm	0	1	1	0	1	0	1	0	1	0
Oropharyngeal carcinoma	0	2	0	2	1	0	0	2	0	2
Maxillary carcinoma	0	1	0	1	1	1	1	0	0	1
Lymphoma	3	0	3	0	3	0	2	0	3	0
Paraganglioma	1	0	1	0	1	0	1	0	1	0
Metastatic carcinoma	0	8	0	8	8	0	8	0	8	0
Papillary carcinoma	0	1	0	1	1	0	0	0	1	0
Adenoid cystic carcinoma	0	1	0	1	0	1	1	0	0	1
Subtotal	6	22	7	21	22	6	26	2	20	8
Total	28		28		28		28		28	

BENIGN LESIONS	BENIGN LESIONS									
	Enhancement		Necrosis		Bone invasion		Vessel invasion		Adjacent space	
	Homogenous	Heterogenous	Negative	Positive	Absent	Present	Absent	Present	Absent	Present
Hemangiomas	2	0	2	0	2	0	2	0	2	3
Nasophryngeal angiofibroma	0	1	1	0	0	1	1	0	1	0
Abscess	0	6	6	0	6	0	6	0	2	3
Lymph nodes	2	0	2	0	2	0	2	0	2	0
Lymphangioma	0	2	0	2	2	0	2	0	2	0
Branchial cleft cyst	2	0	2	0	2	0	2	0	2	0
Adenoids	1	0	1	0	1	0	1	0	1	0
Parathyroid adenoma	0	1	0	1	1	0	1	0	1	0
Vagal schwannoma	0	2	2	0	2	0	2	0	2	0
Post radiation necrosis	1	0	1	0	1	0	1	0	1	0
Mandibular AVM	0	1	1	0	1	0	1	0	1	0
Trigeminal schwannoma	0	1	0	1	0	1	1	0	0	1
Subtotal	8	14	18	4	20	2	22	0	16	6
Total	22		22		22		22		22	

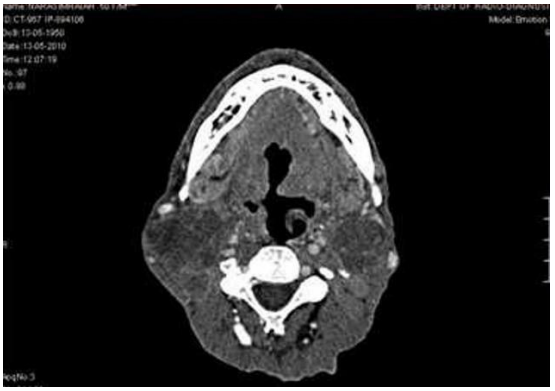
Table 4: DISTRIBUTION OF NECK LESIONS IN NECK SPACES (n=50)

NECK SPACE	NUMBER	%
Masticator space	5	10%
Buccal space	5	10%
Parotid space	3	6%
Parapharyngeal space	12	24%
Retropharyngeal space	1	2%
Prevertebral space	2	4%
Carotid space	3	6%
Submandibular space	3	6%
Visceral space	9	18%
Pharyngeal mucosal space	5	10%
Posterior cervical space	2	4%

Table 5: Sensitivity and specificity of CECT in diagnosing lesions of neck

Lesions according to space	Sensitivity	Specificity	PPV	NPV	Accuracy	P value
Submandibular space	100	100	100	100	100	<0.001
Masseteric space	100	97.8	80	100	98	<0.001
Buccal space	80	100	100	98	98	<0.001
Parapharyngeal space	100	100	100	100	100	<0.001
Carotid space	100	100	100	100	100	<0.001
Parotid space	100	100	100	100	100	<0.001
Pharyngeal mucosal space	100	100	100	100	100	<0.001
Retropharyngeal space	100	100	100	100	100	<0.001
Prevertebral space	100	100	100	100	100	<0.001
Posterior cervical space	100	100	100	100	100	<0.001
Visceral space	100	100	100	100	100	<0.001

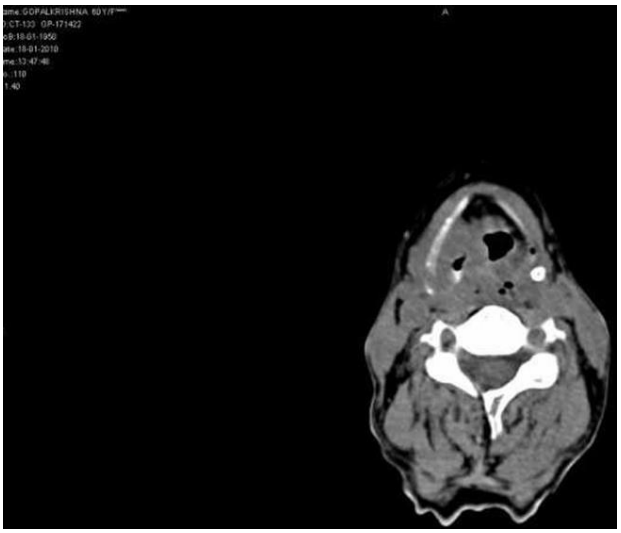
FIG 1.



A 67 year old male with metastatic lymph nodes at level II:

Axial sections of CECT showing multiple hypodense lesions with heterogeneous enhancement with non-enhancing hypodense central areas suggesting necrosis in parapharyngeal spaces bilaterally.

FIG 2.



A 58 year old male with laryngeal carcinoma:

Axial section of CT at thyroid cartilage level demonstrating a lesion with irregular margins and heterogeneous enhancement in the glottis.

Fig 3. Calculation of volume of lesion by MDCT

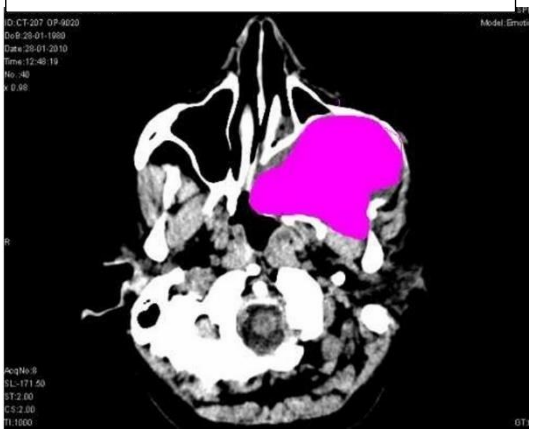
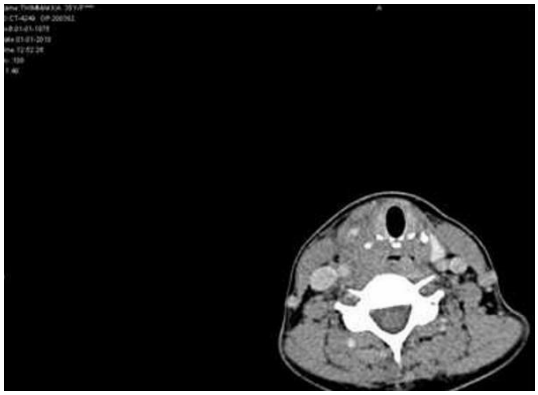


Fig 4. Axial section of CECT demonstrating thickened prevertebral soft tissue with few air pockets suggestive of prevertebral abscess



DISCUSSION

The role of CT scan in the evaluation of lesions of neck has been studied in the present study. Role of CT scan in identification and defining extent of the lesions has been studied.

22(44%) cases had benign findings while 28(56%) cases had malignant findings, out of the total 50 cases. Malignant lesions, having a rapid rate of growth showed early symptoms and hence draw the patient's early attention to visit the doctor early. The age group for majority (76.5%) of head and neck region localized benign lesions was below 50 years. Majority of malignant lesions (74.8%) occurring in the head and neck region namely carcinomas of pharyngeal mucosal space, metastatic lymph nodes, visceral space carcinomas and oral carcinomas were seen in patients aged above 40 years. Hasan Altumbabic et al (2008)[10] in their study found that most common cancers were laryngeal cancers while cancer of oro-pharynx were second most common. Parapharyngeal space (24%) is the most commonly involved, while visceral space (18%) is the second most commonly involved neck space in the present study. Metastatic lymph nodes and greater incidence of carcinoma of larynx may have attributed to this. C. Eskey et al (2000)[11] in their study stated that necrosis is seen in malignant lesions more frequently. 6 patients (20%) with malignant lesions showed bony involvement, while 3 patients (13.6%) with benign lesions showed bony involvement. The benign lesions caused expansion and remodeling of the bone, while the malignant lesions caused bony erosion. The current study correlated with this study. 8 cases (26.66%) with malignant lesions and 5 cases (22.5%) with benign lesions (one case with trigeminal schwannoma, one case with nasopharyngeal angiofibroma, 3 cases with abscesses) showed extension into adjacent space. Abhinandan Bhattajaree (2004)[12] in their study reported a male preponderance of neck malignancies. Wang L F[13] in their study on infections of spaces of head and neck stated that the mean age was 41.7 years with a preponderance in male population. Otto R A et al[14] in their study found that in the neck region, most of the lesions that are benign occurred in pediatric and young adult patients, while most of the lesions that

are malignant occurred in the elderly. Freling et al (2009)[15] carried out a study on patients suspected clinically with abscess of deep neck, by CECT examination. They reported 82% positive predictive value and 100% negative predictive value for the presence or absence of an abscess.

This study has a few limitations. First, radiation exposure to the patient which should be maintained to minimum possible levels. Second, risk of contrast induced anaphylaxis. A test dose should be given prior to the study and observed for reaction. The patient should be kept under observation post study for delayed reactions.

Contrast Enhanced Computed Tomography can diagnose neck lesions with improved accuracy in characterization and localization of the lesions[16]. Demonstration of the lesion accurately by CECT provides a pre-operative diagnosis, radiotherapy ports planning and follow up post treatment. CECT is advantageous in detection of bony lesions (expansion and erosions). Recent advances in MDCT makes thinner collimation possible with the use of SSD, MIP and MPR images, which help in localization of lesions in neck[17]. Advantages include faster time for scan acquisition, less artifacts due to patient motion, no contraindications for patients with electrical devices implanted. Relatively lesser cost and accessibility to lower socioeconomic group makes CT a practical modality. Easy availability and fast acquisition time make CT a useful modality for initial evaluation, biopsy planning, preoperative planning and follow up postoperatively, while MRI may be used as complimentary modality for tumours with perineural spread. However, histopathological diagnosis is still the gold standard as CECT is not 100% accurate.

REFERENCES

1. Stanley E. Thawley M. D, Mokhtar Gado M. D, Thomas R. Fuller M.D. Computerized tomography in the evaluation of head and neck lesions. The Laryngoscope March 1978; 88(3) :451-9.

2. Lee JK, Stuart. S. Computed Body Tomography with MRI Correlation. Lippincott Williams & Wilkins; 2006.

3. Martinez CR, Gayler B, Kashima H, et al. Computed tomography of the neck. Radiographics 1983; 3: 9 - 40.

4. Lell M, Baum U, Koester M, Nömayr A, Greess H, Lenz M.Radiologe. The morphological and functional diagnosis of the head-neck area with multiplanar spiral CT 1999 Nov;39(11):932-8.

5. Baum U, Greess H, Lell M, Nömayr A, Lenz M. Imaging of head and neck tumors-methods: CT, spiral- CT, Multislice-spiral-CT. Eur J Radiol (2000) Mar; 33(3):153-60.

6. H Greessa, A Nömayra, B Tomandlb, M Blankc, M Lella, M Lenza. 2D and 3D Visualisation of Head and Neck Tumors from Spiral-Ct Data (2000) European Journal Of radiology March 2000; 33(3): 170 177.

7. Alberico RA, Husain SH, Sirotkin I. Imaging in head and neck oncology. (2004) Surg Oncol Clin N Am. 2004 Jan;13(1):13-35.

8. S B Gay, D R Pervarski, C D Philips, P A Levine Dynamic CT of the neck. Radiology July 1991; 180: 284-285.8.

9. King AD, Tse GM, Ahuja AT, Yuen EH, Vlantis AC, et al. Necrosis in metastatic neck nodes: diagnostic accuracy of CT, MR imaging, and US. Radiology. 2004 Mar; 230(3):720-6.

10. Hasan Altumbabic, Almir Salkic, Almedina Ramas, Musfaha Burgic, Merima. Pattern of head and neck malignant tumours in a tuzla ENT clinic –A five year experience. Bosnian journal of basic medical sciences .2008; 8 (4): 377-380.

11. C.Eskey, C.Robson, A.Weber. Imaging of benign and malignant soft tissue tumors of the neck. Radiologic Clinics of North America 2000; 38(5):1091-1104.

12. Abhinandan bhattacharjee, A. Chakraborty, P. Purkaystha. Prevalence of Head and neck cancers in the north east -an institutional study. January-March 2006. Indian Journal of Otolaryngology and Head and Neck Surgery; 58 (1): 15-19.

13. Wang LF, Kuo WR, Tsai SM, Huang KJ. Characterizations of life-threatening deep cervical space infections: A review of one hundred ninety-six cases. Am J Otolaryngol. 2003 Mar-Apr;24(2):111-7.

14. Otto RA, Bowes AK. Neck masses: benign or malignant? Sorting out the causes by age-group. Postgrad Med. 1990 Jul; 88(1):199-204.

15. Freling N, Roele E, Schaefer-Prokop C, Fokkens W. Prediction of deep neck abscesses by contrast- enhanced computerized tomography in 76 clinically suspect consecutive patients. Laryngoscope. 2009 Sep;119(9):1745-52.

16. Som P M, Curtin H D: Parapharyngeal Space In Som PM, Curtin H D (eds): Head and Neck Imaging, Ed 3, Vol 2. St Louis, Mosby, 1996, 919-951.

17. Zbären P, Becker M, Läng H. Pretherapeutic staging of laryngeal carcinoma. Clinical findings, computed tomography, and magnetic resonance imaging compared with histopathology. Cancer. 1996 Apr 1;77(7):1263-73.