ROLE OF MULTIDETECTOR CT IN EVALUATION OF NECK LESIONS

Reena Mathur[1], Madhumala[2], Avinash Gupta[3], Ravindra Repswal[4], Sourav K. Singh[5], Prasanna[6], Shyoji Ram[7], Divya Bagoria[8]

[1]Professor & HOD, Department of Radiodiagnosis, J. L. N. Medical College & Hospital, Ajmer, Rajasthan.
[2]3rd Year Resident, Department of Radiodiagnosis, J. L. N. Medical College & Hospital, Ajmer, Rajasthan.
[3]Associate Professor, Department of Radiodiagnosis, J. L. N. Medical College & Hospital, Ajmer, Rajasthan.
[4]3rd Year Resident, Department of Radiodiagnosis, J. L. N. Medical College & Hospital, Ajmer, Rajasthan.
[5]3rd Year Resident, Department of Radiodiagnosis, J. L. N. Medical College & Hospital, Ajmer, Rajasthan.
[6]2nd Year Resident, Department of Radiodiagnosis, J. L. N. Medical College & Hospital, Ajmer, Rajasthan.
[7]2nd Year Resident, Department of Radiodiagnosis, J. L. N. Medical College & Hospital, Ajmer, Rajasthan.
[8]2nd Year Resident, Department of Radiodiagnosis, J. L. N. Medical College & Hospital, Ajmer, Rajasthan.

ABSTRACT

AIMS AND OBJECTIVES

To find out the role of multidetector computed tomography in the evaluation of neck lesions with respect to evaluation of the size, location and extent of tumour. Extension of tumour infiltrating into surrounding vascular and visceral structures. To correlate the findings of MD-CT with final diagnosis by biopsy.

MATERIAL AND METHODS

Data for the study was collected from patients with suspected neck lesions attending Department of Radio-diagnosis, J.L.N. Medical College and Associated Group of Hospitals, Ajmer, Rajasthan. A prospective study was conducted over a period (From 1st March 2014 to 31 Aug. 2015) on 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 using multidetector CT. A provisional diagnosis was made after CT scan and these findings were correlated with histopathology/surgical findings as applicable.

RESULT

In the present study, 97 out of 100 cases were correctly characterised by computed tomography giving an accuracy of 97%. One case of buccal carcinoma was wrongly diagnosed as benign lesion and another case of malignant lymph node was inaccurately diagnosed as benign lymph node, also another case of benign lymph node was inaccurately diagnosed as malignant lymph node.

CONCLUSION

Multidetector Computed Tomography of the neck has improved the localisation and characterisation of neck lesions.
Accurate delineation of disease by CT scan provides a reliable preoperative diagnosis, plan for radiotherapy ports and post-treatment followup. However, histopathology still remains the gold standard as CT is not 100% accurate.

KEYWORDS

Multidetector Computed Tomography, Histopathology, Palpable Neck Mass, Malignant Lymph Node.

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INTRODUCTION: A mass lesion in the neck can be a diagnostic challenge in a patient of any age. Neck masses include a spectrum of lesions of diverse origin and aetiology. Clinical examination alone is limited in its ability to accurately assess the extent and size of head and neck tumours, especially or submucosal extension of disease and extent of nodal metastasis. Computed tomography has found an increasing application in the evaluation of neck masses–both congenital and acquired, and is currently one of the most powerful and versatile imaging procedures for the evaluation of neck masses.

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Corresponding Author:
Dr. Reena Mathur,
House No. 341, Behind Revenue Board, Civil Lines,
Ajmer-305001, Rajasthan.
E-mail: sunrinty@yahoo.com
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Multislice spiral CT provides volumetric helical data, thereby permitting optimal multiplanar and 3D reconstructions.[1] Neck is a conical space that is situated between the base of skull up to the thoracic inlet. It is divided into suprahyoid and infrahyoid part by the hyoid bone. Traditionally, the neck used to be classified based on triangles. But with the advent of cross-sectional imaging, the concept of neck spaces has come into picture. The neck is divided into spaces by the superficial and deep cervical fascia.[2] The suprahyoid neck spaces include pharyngeal mucosal space, parapharyngeal space, masticator space, parotid space, carotid space, retropharyngeal space, submandibular and sublingual space and perivertebral space.

The infrahyoid neck is the region of the neck extending from the hyoid bone to the thoracic inlet. The anatomy of the infrahyoid neck has been subdivided into anterior and posterior surgical triangles whose borders are readily palpable bones and muscles.

Another approach to the anatomy of the neck is the so called 'spatial approach' in which, the cross-sectional anatomy is described as a series of spaces defined by the various layers of the deep cervical fascia. The infrahyoid neck spaces include visceral space, carotid space, retropharyngeal space, perivertebral space and posterior cervical space.[3] CT with its unique capacity to display osseous and soft tissue details has become an indispensable tool in evaluation of patients with neck mass. CT has proved to be sensitive and reliable in the evaluation of various disease processes. Coupled with a detailed physical examination and modern endoscopy, imaging has become indispensable in the characterisation and staging of neck pathology. It is non-invasive, non-operator dependent and permits the accurate measurement of tissue attenuation coefficient.

Spiral CT scanning is rapidly replacing conventional dynamic CT scanning (slice-by-slice acquisition) in most medical centres. Spiral CT improved the examination quality, reducing the sedation time and requiring lower radiation doses. Multi-slice spiral CT using multiple detector rows is the latest advancement in CT technology. Use of multiple detector rows allows faster scanning and thinner collimation. Multidetector CT permits rapid scanning of large volumes of tissue during quiet respiration. Spiral images are less susceptible to patient motion than conventional CT, although image noise is slightly increased. Volumetric helical data permits optimal multiplanar and three dimensional (3D) reconstructions. 3-dimensional imaging is possible using volume rendering, maximum intensity projection and shaded surface display techniques, which helps the operating surgeon to understand the exact extent of the lesion and its relationship to surrounding structures. Thus, the radiologist can point out to the clinician the pathological findings by some essential images without having to demonstrate all axial slices. Intravenous contrast agent is used to study the enhancement characteristics of the lesion.

Due to faster speed of scanning, motion related problems have decreased. In addition, sedation can be avoided in majority of paediatric patients. It remains the best technique for imaging a bony matrix and it is excellent for identifying small soft tissue calcifications. Nonetheless, CT has its disadvantages. It involves the use of ionising radiation, which are undesirable in children and pregnant women. It requires an iodine based contrast agent injection, which associated possible risk of allergic reactions, and in certain areas of the neck CT does not provide soft tissue definition equivalent to that attainable with MR imaging.[4]

Computed tomography (CT) is often the first diagnostic imaging examination performed in patients in whom the presence of a head and neck mass is either evident or suspected. Although it does not provide the soft tissue contrast resolution obtainable with magnetic resonance (MR) imaging, CT provides valuable information. Certain distinguishing CT characteristics (e.g., the patterns of lesion mineralisation, degree of attenuation, and involvement in adjacent bone, and the degree and pattern of vascularity) may be suggestive of a specific diagnosis.

A lesion containing certain characteristics like large volume, extra-compartmental extension, poorly defined margins, inhomogeneous CT attenuation, invasion of bones and neurovascular structures, intra-tumoural necrosis, marked primarily peripheral enhancement and associated necrotic lymph nodes can differentiate malignant from benign lesions on CT imaging.[5]

In every region of the head and neck, MPRs are useful as additional planes. SSDs are useful if there is extensive bony destruction (Skull, Spine, Skeleton, Larynx). Colour-coded three-dimensional reformations may be done for extensive tumours and before multispeciality surgery. Perspective volume rendering is already in use for virtual laryngoscopy. Two and three-dimensional displays are used to visualise pathological findings in their topographic relation to anatomical leading structures. Thus, the radiologist can point out to the clinician, the pathological findings by some essential images without having to demonstrate all axial slices.[6]

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 tumour 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 for evaluation of the deep spaces and submucosal 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 ionising radiations.[7]

AIMS & OBJECTIVES: To find out the role of multidetector computed tomography in the evaluation of neck lesions with respect to:

1. Evaluation of the size, location and extent of tumour.
2. Extension of tumour infiltrating into surrounding vascular and visceral structures.
3. Nodal staging by standard classification to help the Radiologist, Surgeon, Radiation oncologist and Pathologist.
4. To correlate the findings of MD-CT with final diagnosis by biopsy.

MATERIAL AND METHODS: Data for the study will be collected from patients with suspected neck lesions attending Department of Radio-diagnosis J.L.N. Medical College and Associated Group of Hospitals, Ajmer.

Method of Collection of Data:

Study Design: A prospective study was conducted over a period (from 1st March 2014 to 31 Aug. 2015) on 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 using multidetector CT. A provisional diagnosis was made after CT scan and these findings were correlated with histopathology/surgical findings as applicable.

Inclusion Criteria:

1. Patients with neck swelling.
2. Patients with symptoms pertaining to neck.
3. All patients with suspected neck mass.
4. Patients in whom a neck lesion detected on ultrasound study.

Exclusion Criteria:

1. Cases of trauma excluded from the study.
2. Patients with neck lesion but in whom contraindications to contrast administration present such as contrast hypersensitivity or high renal parameters.
3. Moribund patients.

RESULTS AND OBSERVATIONS:

Study Design: A prospective correlation study to find the efficiency of spiral CT in the evaluation of neck lesions.

Age and Gender Distribution of the Neck Lesion (N=100):

Age Group (yrs.)	Females	(%)	Males	(%)	Total	(%)
<10	0	0	4	7	4	4
11 – 20	8	20	2	3	10	10
21 – 30	8	20	2	3	10	10
31 – 40	2	5	8	13	10	10
41 – 50	6	15	10	17	16	16
51 – 60	6	15	12	20	18	18
61 – 70	8	20	20	34	28	28
71 – 80	2	5	2	3	4	4
Total	40	100	60	100	100	100

Table 1

The current study shows higher incidence of neck mass among males with a male to female ratio of 3:2. Most common neck mass was in the age group of 61-70 years.

Among the Malignant Lesions (n=60)

Lesion	No	%
Larynx CA	16	27
Oropharyngeal CA	2	3
Nasopharyngeal CA	2	3
Buccal CA	8	14
Mandibular CA	2	3
Metastatic LN	18	30
Thyroid CA	4	7
Tongue CA	8	13
Total	**60**	**100**

Table 2

Most common malignant lesions in this series were metastatic lymph nodes followed by laryngeal carcinoma.

Benign Lesions (n = 40)

Lesion	No	%
Nasopharyngeal Angiofibroma	2	5
Benign LN	10	25
Lymphangioma	2	5
Adenoids	2	5
Vagal Schwannoma	4	10
AVM	4	10
Abscess	4	10
CBT	4	10
Benign Thyroid Lesion	6	15
Lipoma	2	5

Table 3

Most common benign lesion in this series were benign lymph-nodes followed by benign thyroid lesion.

Distribution of Neck Mass According to Space (n=100)

Neck Lesion	Frequency	Percent
Masticator space	4	4
Buccal space	16	16
Parotid space	2	2
Parapharyngeal space	0	0
Retropharyngeal space	0	0
Prevertebral space	2	2
Carotid space	6	6
Submandibular space	20	20
Visceral space	26	26
Pharyngeal mucosal space	8	8
Posterior cervical space	16	16

Table 4

The most common lesion in the current series was in visceral space followed by submandibular space.

CT Characteristics of Malignant Neck Mass (n=60)

Malignant Lesions	Enhancement		Necrosis		Bony Invasion		Vascular Invasion		Adjacent Space Invasion	
	Homogeneous	Heterogeneous	Negative	Positive	Absent	Present	Absent	Present	Absent	Present
Larynx CA	4	12	4	12	8	8	16	0	14	2
Buccal carcinoma	2	6	2	6	6	2	6	2	6	2
Nasopharyngeal carcinoma	0	2	0	2	2	0	2	0	2	0
Mandibular CA	0	2	0	2	0	2	2	0	0	2
Oropharyngeal carcinoma	0	2	0	2	2	0	2	0	2	0
Thyroid CA	0	4	0	4	4	0	4	0	4	0
Tongue CA	2	6	2	6	8	0	8	0	8	0
Metastatic LN	4	14	4	14	18	0	18	0	16	2
Subtotal	12	48	12	48	48	12	58	2	52	8
Total	**60**		**60**		**60**		**60**		**60**	

Table 5

Lesions According To Space	Positive		Negative		Total
	True	False	False	True	
Submandibular space	18	1	1	80	100
Masticator space	4	0	0	96	100
Buccal space	15	0	1	84	100
Parapharyngeal space	0	0	0	100	100
Carotid space	6	0	0	94	100
Parotid space	2	0	0	98	100
Pharyngeal mucosal space	8	0	0	92	100
Retropharyngeal space	0	0	0	100	100
Prevertebral space	2	0	0	98	100
Posterior cervical space	16	0	0	84	100
Visceral space	26	0	0	74	100

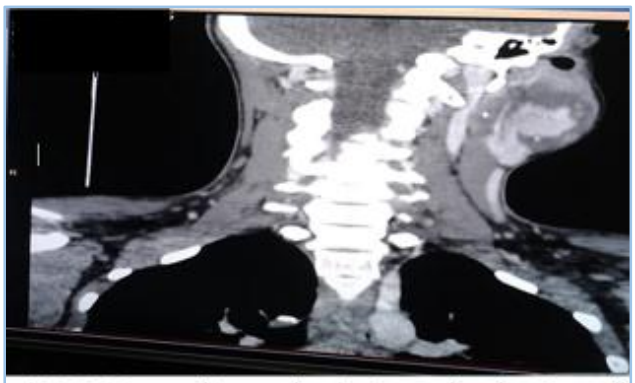
Table 6

In the present study, 97 out of 100 cases were correctly characterised by computed tomography giving an accuracy of 97%. One case of buccal carcinoma was wrongly diagnosed as benign lesion and another case of malignant lymph node was inaccurately diagnosed as benign lymph node, also another case of benign lymph node was inaccurately diagnosed as malignant lymph node.

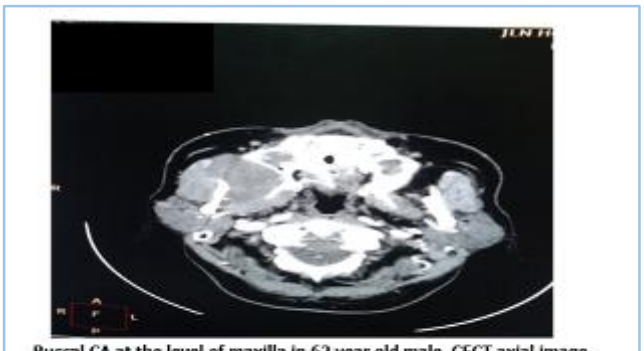
MDCT Neck Lesions – Correlation with Final Diagnosis

Lesions according to Space	Sensitivity	Specificity	PPV	NPV	Accuracy	P value
Submandibular space	94	98	94	98	90	<0.001
Visceral space	100	100	100	100	100	<0.001
Pharyngeal mucosal space	100	100	100	100	100	<0.001
Carotid space	100	100	100	100	100	<0.001
Posterior cervical space	100	100	100	100	100	<0.001
Buccal space	93	100	100	98	93	<0.001
Masticator space	100	100	100	100	100	<0.001
Parotid space	100	100	100	100	100	<0.001
Prevertebral space	100	100	100	100	100	<0.001

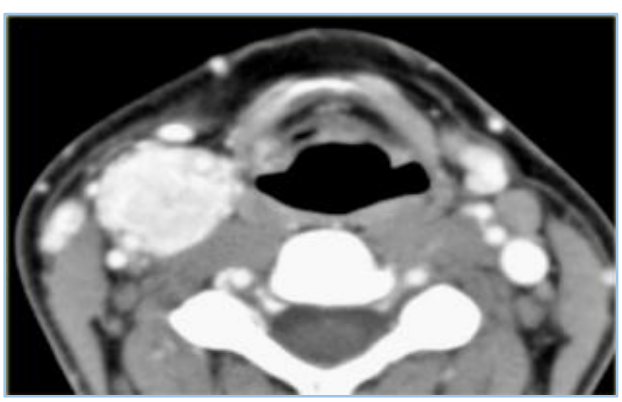
Table 7



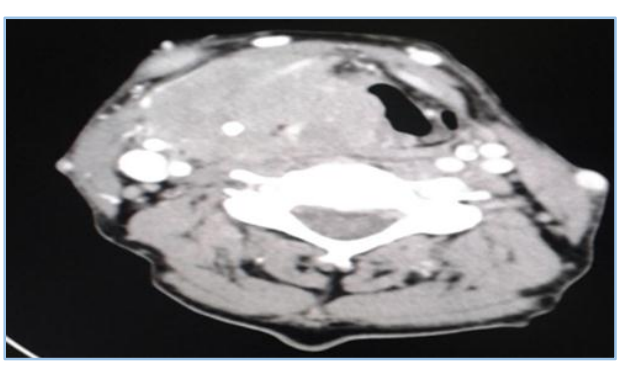
AVM CECT coronal image showing intensely enhancing well defined mass lesion with its relation to artery and vein.



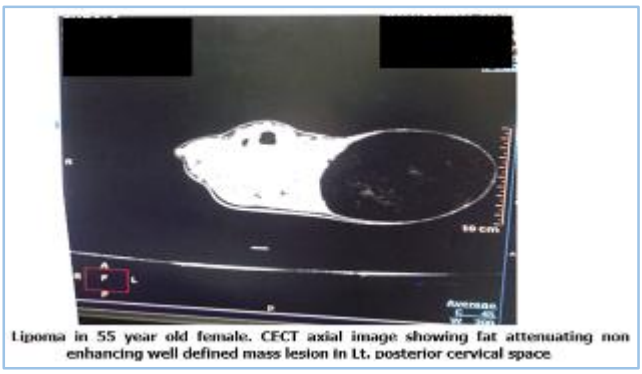
Buccal CA at the level of maxilla in 62 year old male. CECT axial image showing heterogeneously enhancing ill defined mass lesion with its extension into cheek region and maxillary sinus causing lytic bony erosion of Rt. Maxillary sinus wall



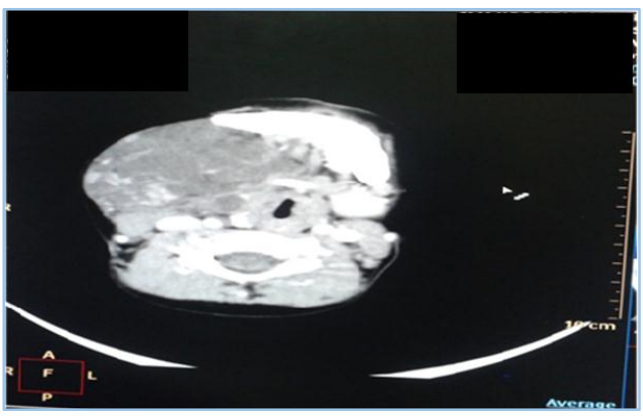
Carotid Body Tumour in a 22-year-old Female. CECT axial image showing well defined intensely enhancing mass lesion at the bifurcation of CCA on Rt. Side causing splaying of internal and external carotid arteries and lateral displacement of Rt. Internal Jugular vein.



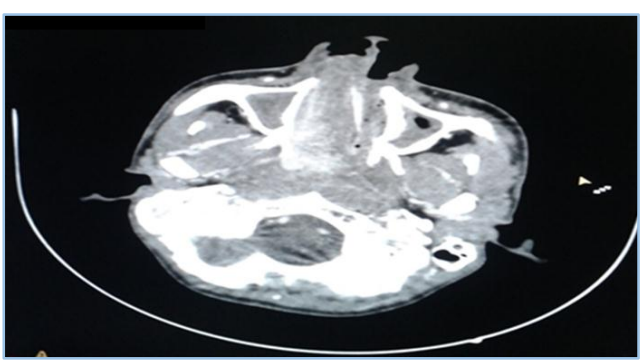
Larynx CA in 64 year old male. CECT axial image showing heterogeneously enhancing mass lesion in Glottic and Supra Glottic part of Larynx with lytic erosion of Rt. Thyroid cartilage.



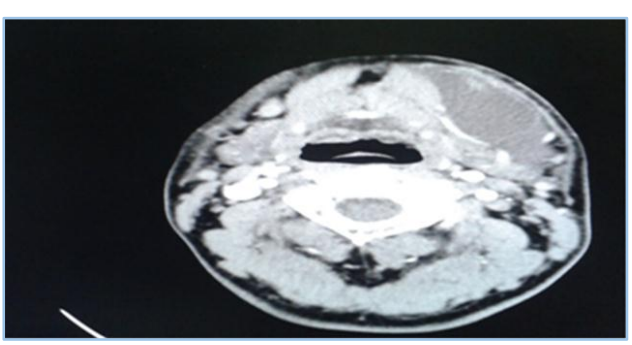
Lipoma in 55 year old female. CECT axial image showing fat attenuating non enhancing well defined mass lesion in Lt. posterior cervical space



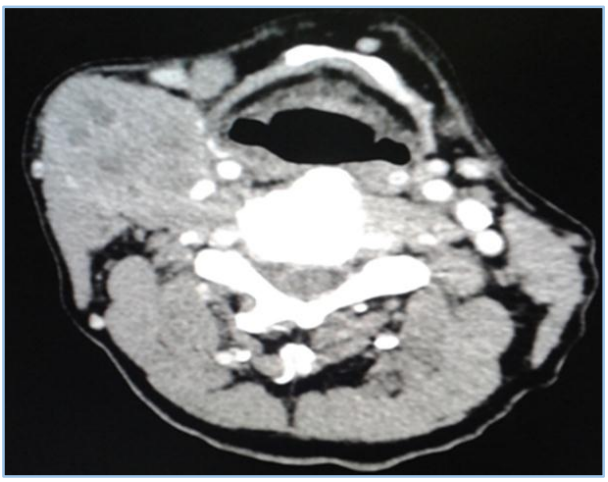
Lymphangioma in a 2-year-old male child, CECT axial image showing multi-loculated cystic lesion on Rt. side



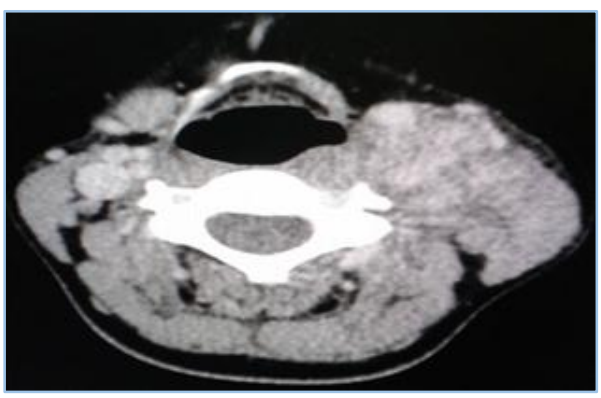
Nasopharyngeal angiofibroma in a 15-year-old male. CECT axial image showing at the level of pterygoid plates depicts a heterogeneously enhancing mass with non-enhancing necrotic areas in pharyngeal mucosal space causing widening of right pterygopalatine fossa with extension into right Nasal Cavity.



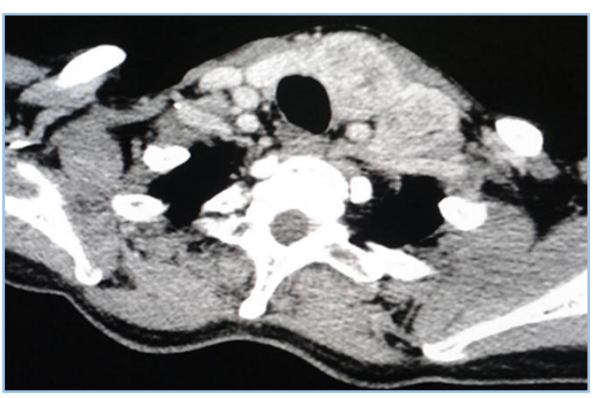
Submandibular space abscess in 22 year old male. Axial CECT image at the level of mandible showing non-enhancing collection with enhancing walls.



Metastatic Lymphnode at level II in 65 year old male. Axial CECT image showing multiple heterogeneously enhancing lesions with central non-enhancing hypodense areas suggestive of necrosis in para pharyngeal space.



Vagal Schwanoma in 57 year old male. Axial CECT image in arterial phase showing well defined heterogeneously enhancing mass lesion in Lt. carotid space displacing carotid vessels anterio medially and stretching, compressing internal jugular vein laterally.



Thyroid CA in a 46-year-old female. Axial CECT image showing heterogeneously enhancing Lt. lobe of thyroid with loss of adjacent fat planes

DISCUSSION: The present clinical study was conducted in hospitals attached to Department of Radio-diagnosis, viz, Jawaharlal Nehru Medical College and Associated Group of Hospitals Ajmer (Raj). During 18 months period (March 2014 to August 2015), a total of 100 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. Provisional diagnosis was given and was correlated with histopathological and postoperative diagnosis. The clinical, radiological & histopathological data of the patients have been presented in the following sections. In the present study, an attempt has been made to study the importance of the CT scan in evaluation of neck lesions. This includes studying the usefulness of CT scan not only in identifying the lesion but also in delineating the extensions of the lesion. The computed tomographic scans of 100 patients who were found to have lesions of neck were analysed with available similar studies.

Out of 100 cases studied, 40 (40%) were of benign aetiology and 60 (60%) were of malignant aetiology, the rapid growth and early severe symptoms of malignant lesions draw early attention and make the patients to seek medical help early. Most (75 %) of the benign lesions of the head and neck region was below the age of 40 years.

Most (90%) of the malignant lesions of the head and neck region in this series including oral carcinomas and pharyngeal mucosal space carcinomas and visceral space carcinomas and metastatic lymph nodes were above the age of 40 years except for 6 cases wherein 4 cases of laryngeal carcinoma in 35, 38, 39, 40-year-old males, 2 cases of malignant lymph nodes in 35-40 years female were diagnosed. In the present study, male predominance of malignant lesions was detected with a male to female ratio of 2:1; 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.

The most common neck lesion in this study was lymph node 28 cases (28 %) out of which 18 were malignant lymph nodes and 10 were benign nodes. The most common malignant lesion in the neck in the present study was metastatic lymph nodes 30%) followed by laryngeal carcinoma (27%). The most common space involved in the present study was visceral space (26%) followed by submandibular space (20%). This could be attributed to the metastatic lymph nodes in this space and higher incidence of laryngeal carcinomas in the present study.

As study done by Dr. Dhaval K Thakkar et al. (Aug. 2015) on evaluation of neck lesions with MDCT, the following results were seen. There was male preponderance (66%), with females accounting for 34% of total cases. 34/100 (34%) were of malignant aetiology, 24 (24%) were of benign aetiology, 33 (33%) inflammatory aetiology, 6 (6%) were congenital and 3 (3%) were of vascular aetiology. The main differentiating features between benign and malignant lesions were well-defined margins and fat plane for benign lesions. Cystic hygroma (3/6=50%) was most common congenital lesions, IJV thrombosis (2/3=66.67%) in vascular lesions, retropharyngeal abscess (6/33=18.18%) in inflammatory lesions. Goitre (5/24=20.83%) predominated followed by parathyroid adenoma (4/24=16.67%) in benign lesions. In malignant aetiology, metastatic lymph nodes were seen in 7/34=20. 58%, primary malignancy could be detected in 24/34 (70.58%) cases. Visceral space (31%) was the most commonly involved neck space.

The CT imaging diagnosis was confirmed with biopsy, FNAC, surgery, or by pathognomonic imaging findings on contrast enhanced CT. Another study done by Dr. Ravi. N. (March 2015) on Does MDCT Really Have a Role in the Evaluation of Neck Masses? The following results were seen. The age range in the study was from 0 years to 80 years. The largest group of patients (22%) was in 41-50 years age group and second largest group of patients (18%) was in the age range of 31-40 years, 66 cases were males and 34 cases were females with male to female ratio of 1.9:1.

In present study, regarding the CT characteristics of benign and malignant neck lesions, necrosis was present in 80% of the malignant lesions. Bony involvement was seen in 12 cases (20%) of the malignant lesions. The malignant lesions (buccal carcinoma, mandibular carcinoma, and laryngeal carcinoma) caused bony erosion. Extension into the adjacent space was seen in 8 (13.33%) of malignant lesions and in 2 (5%) cases of benign lesions (2 cases of submandibular abscesses). In the present study, out of a total of 100 cases, 4 cases were localised to have masticator space involvement. The sensitivity and specificity of masticator space lesions were 100% and 100% respectively and positive predictive value is 100% and accuracy of 100%. In the present study, out of 100 cases, 16 cases of buccal space lesions were encountered. CT accurately diagnosed 15 out of 16 cases with a sensitivity of 93%, specificity of 100 % and accuracy of 93%. One case was wrongly identified as benign and histopathologically proven as malignant.

In the present study, 2 cases of parotid lesions were encountered, in 2 cases of parotid abscess CT accurately diagnosed the lesions in all the 2 cases with sensitivity and specificity of 100%. In the present study, 8 cases of pharyngeal mucosal lesions were diagnosed; 2 cases of adenoid hypertrophy, 2 cases of juvenile angiofibroma, 2 cases of nasopharyngeal carcinoma, 2 cases of oropharyngeal carcinoma. CT could accurately diagnose the cases in all 8 patients with sensitivity and specificity of 100%.

In the present study, 2 cases of nasopharyngeal angiofibroma was diagnosed in a young adolescent male characteristically involving the pterygopalatine fissure and the nasopharynx and secondarily invading the maxillary and ethmoid sinuses with characteristic intense vascular enhancement on contrast administration.

In the present study, a total of 28 lymph nodes were encountered, 10 benign and 18 malignant. Based on size criteria and central necrotic area, CT differentiated benign and malignant lymph nodes with 96% sensitivity and specificity and an accuracy of 93%. In the present study, CT was able to localise lymph nodes accurately and characterise the lymph nodes.

In the present study, 16 cases of laryngeal carcinomas were encountered. All 16 cases of laryngeal carcinomas were accurately diagnosed with 100% sensitivity and specificity.

In the present study, 4 cases of thyroid malignancy was encountered which was accurately diagnosed as bone/cartilaginous involvement.

Patients of bony involvement in present study were secondary to laryngeal carcinoma, buccal carcinoma and mandibular carcinoma. In the present study, CT demonstrated bony changes in all the above cases. Malignant lesions caused bony erosions and bony invasions. With regard to individual aetiologies, there was an overall accuracy of 97% accuracy in diagnosing neck lesions. One false positive case which we encountered in this study was a case of benign lymph node which was wrongly diagnosed as malignant lymph node. There was heterogenous enhancement of the lesion with central necrosis and hence was wrongly diagnosed as malignant lymph node but histopathologically was proved as benign tubercular lymph node.

Another case of malignant lymph node was wrongly diagnosed as benign lymph node. There was homogeneous enhancement in subcentimetric lymph node and hence wrongly diagnosed as benign lymph node. Another case of malignant lesion in buccal space was wrongly diagnosed as benign as the lesion had well-defined margins and there was no bony erosion. In general, with the evolution of MDCT and the use of coronal and sagittal reformatted images, the sensitivity of localising neck mass has gone up.

SUMMARY: Among 100 cases studied, 40 (40%) were benign and 60 (60%) were malignant neck lesions. Overall, there was a male preponderance with 60 (60%) males and 40 (40%) females and with a male to female ratio of 3:2. Among the neck lesions, the most common was metastatic lymph node mass (30%) followed by laryngeal carcinoma (27%). Benign lesions were common in the age group of 21-30 with a female to male ratio of 4:1. Malignant lesions were more common in the elderly age group of 61-70 years with a male to female ratio of 2:1.

The most common space involvement was visceral space (26%) followed by submandibular space (20%).

MDCT has 97% accuracy in diagnosing neck lesions.

MDCT has 100% accuracy in predicting bony involvement in head and neck cancers. Advantages of MDCT includes ability to perform thin slice scanning with thinner reconstruction intervals and ability to perform MIP, SSD, MPR and curved reformatted images. Thus, MDCT has an excellent accuracy in localising and characterising of the neck lesions.

CONCLUSION: From this study, we conclude that Multidetector Computed Tomography of the neck has improved the localisation and characterisation of neck lesions with its ability to detect bony lesions (erosions and expansion). Since CT is fast, well tolerated, and readily available and low cost, it can be used for initial evaluation, preoperative planning, biopsy targeting, plan for radiotherapy ports and postoperative followup and reserve MRI as a complementary imaging modality or for those tumours that may have higher chance of perineural spread. However, histopathology still remains the gold standard as CT is not 100% accurate.

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