Role of MDCT Scan in evaluation of neck mass lesions

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Abstract

Aim: To localize and characterize neck lesions with respect to anatomical delineation, extension to adjacent structures and bony involvement.
Materials and Methods: For this prospective study the data was collected from patients attending department of radio-diagnosis at LG Hospital, AMCMET medical college, Maninagar Ahmedabad. Total 150 patients presented with symptoms of palpable neck mass and neck pain were recruited. Patients were evaluated with Multidetector CT (Mx Philips 16 slice) and patients who were diagnosed having neck mass on CT scan study. The pathological lesions were evaluated with respect to the density, size of the lesion, location of the lesion, enhancement pattern, presence of calcification, presence of fat, extension into adjoining structures and presence or absence of venous thrombosis and bony involvement.
Results: Most common benign neck mass was in the age group of 31-40 years. Incidence of malignant lesions was observed between 61-70 years (40%). Higher incidence among males was noted with a male to female ratio of 2:1. Necrosis was present in 67.6% of the malignant lesions. Bony involvement was seen in 34 cases (40.47%) of the malignant lesions. Vascular involvement in the form of jugular vein thrombosis was seen in 10.71% of malignant lesions. Extension into the adjacent space was seen in 43 (51.19%) of malignant lesions.
Conclusion: The most common space involvement was parapharyngeal space (24%) followed by pharyngeal mucosal space (18%). MDCT has 96% accuracy in diagnosing neck lesions. MDCT has 100% accuracy in predicting bony involvement in head and neck cancers.

Keywords: MDCT, head and neck cancers, benign and malignant lesions

Introduction

The development of computerized tomography (CT) has been called the most important contribution to medical diagnostic techniques since Roentgen discovered the X-ray in 1895. By the introduction of cross sectional imaging a new dimension in evaluation of neck lesions has evolved. CT is useful in evaluation of head and neck lesions such as lesions of nasopharynx, base of skull, the larynx and neck areas. CT has added the horizontal plane in the evaluation of these lesions. The ease of obtaining CT scans and rapid scan acquisition are its advantages. The transaxial orientation of CT planes is particularly useful in certain

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locations such as the pterygopalatine fossa. As technology advances in the use of CT, its application in head and neck lesions has increased. Neck is a conical space that is situated between the base of skull upto 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 twelve spaces by the superficial and deep cervical fascia [1].

CT with its unique capacity to display osseous and soft tissue details has become an indispensable tool in evaluation of patients with neck mass.5Spiral CT scanning is rapidly replacing conventional dynamic CT scanning (slice-by-slice acquisition) in most medical centers. Spiral CT permits rapid scanning of large volumes of tissue during quiet respiration. Spiral CT is less susceptible to patient motion than conventional CT. Volumetric helical data permits optimal multiplanar and 3D reconstructions.

Spiral-CT is standard for imaging neck tumours. Secondary coronal reconstructions of axial Scans are helpful in the evaluation of the crossing of the midline by small tumours of the tongue base or palate. 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 [2].

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). Color-coded three-dimensional reformations may be done for extensive tumors and before multi-specialty surgery. Perspective volume rendering is already in use for virtual laryngoscopy. Two and three-dimensional displays are used to visualize 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 [3].

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 [4]. To localize and characterize neck lesions with respect to anatomical delineation, extension to adjacent structures and bony involvement.

Materials and Methods

Data for the study was collected from patients attending department of radio-diagnosis at LG Hospital, AMCMET medical college, Maninagar Ahmedabad.

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Method of collection of data

A prospective study was conducted over a period of 2 years (July 2018 to October 2020) on 150 patients with clinically suspected neck lesions or patients who were referred to CT for further characterization. The patients presented with symptoms of palpable neck mass and neck pain. Patients were evaluated with Multidetector CT (Mx Philips 16 slice) and patients who were diagnosed having neck mass on CT scan study.

Inclusion criteria

1. Patients with neck swelling.
2. Patients with symptoms pertaining to neck.
3. All patents with suspected neck mass and who were diagnosed having neck mass on CT scan study.
4. Lymphadenopathy accompanied with other neck mass were included.

Exclusion criteria

1. Cases of trauma were excluded from the study.
2. Patients with neck lesion but in whom contraindications to contrast administration were present such as contrast hypersensitivity or high renal parameters. (High renal parameters specifically creatinine > or equal to 1.5).
3. Only patients who were having only nodal enlargement were not included, however nodal mass were included.

Preparation of the patients

Patients were kept nil orally 8hourspriorto CT scan to avoid complications while administrating contrast medium. Risk of contrast administration were explained to the patient and consent was taken prior to the contrast study. Routine lateral to program 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 2.5mm sections. In all patients' plain study was followed by contrast study using 4mm sections and reconstructions to1.5mm thinner sections. Contrast study was done using 50 ml of IV contrast agent and images were taken in arterial and venous phase.
Post processing reconstructions were done using 1.5mm reconstructions. Techniques such as Maximum intensity projections and minimum intensity projections were done as and when necessary.
Scans were reviewed in appropriate windows i.e., mediastinum window, laryngeal window and bone window.
The pathological lesions were evaluated with respect to the density, size of the lesion, location of the lesion, enhancement pattern, presence of calcification, presence of fat, extension into adjoining structures and presence or absence of venous thrombosis and bony involvement.

Statistical analysis

Descriptive statistical analysis has been carried out in the present study. Results of continuous measurements are presented on mean +/- standard deviation (min-max) and results on categorical measurements are presented in number (%). Significance is assessed at 5% level of significance. Chi-square test /Fischer exact test has been used to find the significance of association of CT scan findings with the final diagnosis. Diagnostic statistics such as sensitivity, specificity, positive predictive value, negative predictive value and accuracy has been used to find the correlation of CT scan with final diagnosis.

Table 1: Age and gender distribution of the benign lesion (n=66)

Age Group (yrs)	Females	(%)	Males	(%)	Total	(%)
< 10	1	3%	0	0%	1	1%
11-20	2	6%	2	5%	4	6%
21-30	9	28%	11	32%	20	30%
31-40	13	40%	17	50%	30	45%
41-50	3	9%	1	0%	4	6%
51-60	2	6%	1	3%	3	4%
61-70	1	3%	1	3%	2	3%
71-80	1	3%	1	3%	2	3%
Total	32	21%	34	22%	66	100%

Most common benign neck mass was in the age group of 31-40 years. The current study shows slightly higher incidence of benign neck mass among males with a male to female ratio of 1.1:1.

Table 2: Age and gender distribution of malignant lesion (n=84)

Age Group (yrs)	Females	(%)	Males	(%)	Total	(%)
<10	0	0	0	0	0	0
11-20	0	0	0	0	0	0
21-30	0	0	1	1%	1	1%
31-40	2	7%	1	1%	3	3%
41-50	3	10%	9	16%	12	14%
51-60	6	21%	11	19%	17	20%
61-70	14	50%	27	48%	41	48%
71-80	3	10%	7	12%	10	11%
TOTAL	28	23 %	56	47%	84	100%

The current study showing higher incidence of malignant lesions between 61-70 years (40%). Higher incidence among males was noted with a male to female ratio of 2:1.

Table 3: CT characteristics of neck mass-malignant lesions (n=84)

Malignant Lesions	Malignant Lesions									
	Enhancement		Necrosis		Bony invasion		Vascular invasion		Adjacent space extension	
	Homogenous	Heterogenous	Absent	Present	Absent	Present	Absent	Present	Absent	Present
Laryngeal carcinoma	3(11%)	10 (17%)	3	10	9(18%)	4(11%)	13	0	3	10
Buccal carcinoma	1(3%)	6(10%)	1	6	5(10%)	2(5%)	7	0	7	0
Nasopharyngeal carcinoma	5(18%)	8(14%)	5	8	1(2%)	12(35%)	13	0	2	11
Submandibular neoplasm	1(1%)	2(3%)	1	2	3(6%)	0(0%)	3	0	3	0
Oropharyngeal carcinoma	2(7%)	5(8%)	2	5	7(14%)	0(0%)	6	1	1	6
Maxillary carcinoma	0(0%)	1(1%)	0	1	0(0%)	1(3%)	1	0	0	1
Lymphoma	3(11%)	1(1%)	3	1	3(6%)	1(3%)	4	0	4	0
Paraganglioma	6(22%)	3(5%)	6	3	9(18%)	0(0%)	9	0	7	2

Metastatic carcinoma	0(0%)	8(14%)	0	8	8(16%)	0(0%)	8	0	8	0
Thyroid carcinoma	6(22%)	12(21%)	6	12	5(10%)	13(38%)	10	8	6	12
Adenoid cystic carcinoma	0(0%)	1(1%)	0	1	0(0%)	1(3%)	1	0	0	1
Subtotal	27(32%	57(67%)	27	57	50(59%)	34(40%)	75	9	41	43
Total	84		84		84		84		84	

Necrosis was present in 67.6% of the malignant lesions. Bony involvement was seen in 34 cases (40.47%) of the malignant lesions. Vascular involvement in the form of jugular vein thrombosis was seen in 10.71% of malignant lesions. Extension into the adjacent space was seen in 43 (51.19%) of malignant lesions.

Table 4: CT characteristics of neck mass-benign lesions (n=66)

Neck Lesions	Benign Lesions									
	Enhancement		Necrosis		Bony invasion		Vascular invasion		Adjacent space extension	
	Homogenous	Heterogenous	Absent	Present	Absent	Present	Absent	Present	Absent	Present
Hemangiomas	7(19%)	0(0%)	7(18%)	0(0%)	7	0	7	0	4	3
Nasopharyngeal angiofibroma	9(25%)	0(0%)	9(23%)	0(0%)	8	1	9	0	6	1
Abscess	5(13%)	14(46%)	5(13%)	14(50%)	19	0	19	0	15	4
Lymph nodes	10(27%)	11(36%)	10(26%)	11(39%)	21	0	21	0	21	0
Lymphangioma	0(0%)	2(6%)	0(0%)	2(7%)	2	0	2	0	2	0
Branchial cleft cyst	2(5%)	0(0%)	2(5%)	0(0%)	2	0	2	0	2	0
Adenoids	1(2%)	0(0%)	1(2%)	0(0%)	1	0	1	0	1	0
Parathyroid adenoma	0(0%)	1(3%)	0(0%)	1(3%)	1	0	1	0	1	0
schwannoma	1(2%)	2(6%)	3(7%)	0(0%)	3	0	3	0	3	0
Post radiation necrosis	1(2%)	0(0%)	1(2%)	0(0%)	1	0	1	0	1	0
Mandibular AVM	0(0%)	0(0%)	0(0%)	0(0%)	0	0	0	0	0	0
Total	36(54%)	30(45%)	38(57%)	28(43%)	65	1	66	0	58	8
	66		66		66		66		66	

Total 45% of benign lesions showed heterogeneous contrast enhancement. Bony involvement was seen in 1(1.5%) cases of benign lesions. Extension into the adjacent space in 8 (12.1%) cases of benign lesions.

Table 5: Sensitivity and specificity of MDCT for diagnosis of neck lesions (n=150)

Lesions according to space	Positive		Negative		Total
	True	False	False	True	
Submandibular space	4	O	0	145	150
Masseteric Space	5	1	0	145	150
Buccal space	4	O	1	145	150
Parapharyngeal space	12	0	0	138	150
Carotid space	3	0	0	147	150
Parotid space	3	0	0	147	150
Pharyngeal mucosal space	5	0	0	145	150
Retropharyngeal space	1	0	0	149	150
Prevertebral space	2	0	0	148	150
Posterior cervical space	2	0	0	148	150
Visceral space	9	0	0	141	150

In the present study 148 out of 150 cases were correctly characterized by Computed tomography giving an accuracy of 96%. One case of buccal carcinoma was wrongly diagnosed as benign lesion and another case of post radiation necrosis was inaccurately diagnosed as tumor recurrence.

Table 6: MDCT neck lesions-final diagnosis

Lesions according to space	Sensitivity	Specificity	PPV	NPV	Accuracy
Submandibular space	100	100	100	100	100
Masseteric space	100	97.8	80	100	98
Buccal space	80	100	100	98	98
Parapharyngeal space	100	100	100	100	100
Carotid space	100	100	100	100	100
Parotid space	100	100	100	100	100
Pharyngeal mucosal space	100	100	100	100	100
Retropharyngeal space	100	100	100	100	100
Pre-vertebral space	100	100	100	100	100
Visceral space	100	100	100	100	100

Discussion

The present clinical study was conducted in hospitals attached to Department of Radio-diagnosis, viz, LG hospital, AMCMET Medical College, Ahmedabad. During 24 months period (July 2018 to October 2020), a total of 150 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 upon ultrasound study. Patients were evaluated with Multidetector CT (Mx Philips 16).

In the present study most (88%) of the benign lesions of the head and neck region was below the age of 50 years. 74.8% 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 1 cases wherein a case of adenoid cystic carcinoma of the parotid in a 40 year female, a case of buccal carcinoma in 39 years female, 2 cases of lymphoma, one in 11year old female and another in 32 year old male were diagnosed.

A study done by Otto RA *et al*. 61states that most of the benign lesions of neck occur in pediatric and young adults group and most of the malignant conditions occur in the elderly [5]. In another study done by Ravimerhotra *et al.* (2005) showed that the prevalence of head and neck malignancy was highest in patients belonging to the 50-59 years age group [6].

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. A study done by Abhinandan Bhattajaree (2004) also a showed a male preponderance of malignant lesions in neck [7]. Another study done by Ravi Merhotra *et al*. (2005) 62 on lesions of the head and neck region also reported a male preponderance [6].

The most common neck lesion in this study was lymph node 54 cases (36%) out of which 32 was malignant lymph-node (21.33%) and 22 were benign nodes. In one series done by Reede *et al*. (1982) also found that the most common neck lesion encountered was lymph-node mass [8].

The most common malignant lesion in the neck in the present study was metastatic lymph nodes (21.33%) followed by thyroid (21%) and laryngeal carcinoma (15.8%). In the study by Abhinandan Bhattajaree (2004) oropharyngeal cancers was most common malignancy followed by oesophageal cancers. In their study cervical lymph nodes ranked sixth and laryngeal cancer ranked fifth [7].

The most common space involved in the present study was parapharyngeal space (24%) followed by visceral space (18%). This could be attributed to the metastatic lymph-nodes in this space and higher incidence of laryngeal carcinomas in the present study.

Necrosis was present in 67.8% of the malignant lesions. In a study by C. Eskey *et al*. (2000) 91 states that necrosis is more frequently seen in malignant lesions. Bony involvement was seen in 34 cases (40.47%) of the malignant lesions and in 1(1.5%) cases of benign lesions [9].

The benign lesions (trigeminal schwannomas, nasopharyngeal angiofibroma and mandibular AVM) caused bony expansion and remodeling rather than bony destruction and erosion. Whereas the malignant lesions (buccal carcinoma, nasopharyngeal carcinoma, adenoid cystic carcinoma, maxillary carcinoma and laryngeal carcinoma) caused bony erosion.

The present study correlated with the study conducted by Janakarajah *et al*. (1984) 90 who states that benign tumors are slow growing and show bony expansion than bony destruction whereas malignant lesions and chronic granulomatous infections shows bony destruction [10].

Extension into the adjacent space was seen in 43 (51.19%) of malignant lesions and in 8 (12.1%) cases of benign lesions (3 cases of abscesses, a case of nasopharyngeal angiofibroma and in case of schwannoma). The study by Janakarajah *et al*. (1984) states that intracranial and intraorbital extension is more common in malignant lesions but are also seen in infections [10].

In this present study total of 43 deep neck space infections (1 retropharyngeal, 4 pre-vertebral, 14visceral space and 8sub-mandibular) were encountered which were accurately diagnosed by CT with a sensitivity and specificity of 100% and positive predictive and negative predictive values of 100%. Among the deep neck space infections 66.66% were among males and the most common age group affected was around fourth decade (below age of 40) (66.66%). Wang LF65conducted a study on Space infection of the head and neck and concluded that there is male preponderance with a mean age of 41.7 years [11]. Freling *et al*. (2009) 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% [12].

Higher positive predictive value in our study may be attributed to the lower sample size. Lazor JB *et al*. (1994) compared computed tomography and surgical findings in deep neck infections in a 10-year retrospective study on 38 patients. In their study the false-positive rate was 13.2% and the false-negative rate was 10.5%. The sensitivity of computed tomography scan for detection of parapharyngeal space or retropharyngeal space abscess was 87.9% [13].

Holt GR *et al*. (1984) studied deep neck space abscess on 22 patients and identified neck abscess in 6 cases in their study There were no false-positives or false-negatives in the series. In all six cases of abscesses, the CT scan accurately identified the anatomical location of the abscess, allowing a more accurate planning of the surgical approach [14].

In the present study, out of a total of 150 cases, 15 cases were localized to have masticator space involvement. Out the 15 cases 7were primary masticator space lesions (7case of masseteric hemangioma and no case of mandibular AVM), 3 benign schwannoma, 1 post radiation necrosis and 4were secondary involvement of the space from adjacent spaces. The sensitivity and specificity of masticator space lesions were 100% and 97.8% respectively and positive predictive value is 80% and accuracy of 98%. A case of post radiation necrosis was wrongly identified as tumor recurrence.

A study done by F. Galli *et al*. (2010) correctly identified the space in 96% of the lesions and characterized the lesions in 93% of cases. In the present study, out of 150 cases,8 cases of buccal space lesions were encountered CT accurately diagnosed 8 out of 8 cases with a sensitivity of 99%, specificity of 100% and accuracy of 98% [15].

In a study done by Kurabayashi *et al*. (1997) using the criteria of ill-defined margins, violation of fascial planes and aggressive bone destruction for the, diagnosis of malignancy only 7 out of 11 malignant tumors were correctly diagnosed with a sensitivity 64% and they

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concluded that CT was useful in demonstrating the presence and location of the mass in buccal space and however the value of CT in differentiating malignant and benign lesions in buccal space is limited [16].

Fig 1a: Axial View **Fig 1b:** Coronal View

Fig 1: Nasopharyngeal carcinoma with its extensions

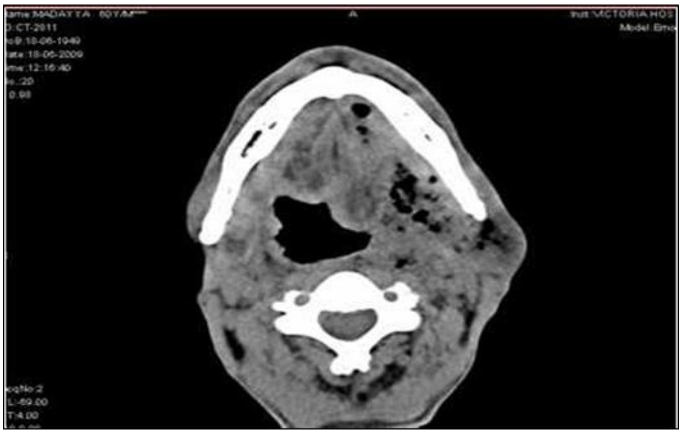

Fig 2: Sub-mandibular space abscess in 60 year old male patient Axial NCCT images at the level of mandible

Conclusion

From this study we concluded that, the most common space involvement was parapharyngeal space (24%) followed by pharyngeal mucosal space (18%). MDCT has 96% accuracy in diagnosing neck lesions. MDCT has 100% accuracy in predicting bony involvement in head and neck cancers.

Multidetector Computed Tomography of the neck has improved the localization and characterization of neck lesions. Accurate delineation of disease by CT scan provides a reliable pre-operative diagnosis, plan for radiotherapy ports and post treatment follow up.

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