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Role Of Mdct In Evaluation Of Neck Masses – A Prospective Study In A Tertiary Care Hospital

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Abstract
Background : *Mass in neck is a common entity encountered in clinical practice. Diagnosis of neck masses is challenging owing to the intricate anatomy of neck and with a myriad of presenting symptoms. The purpose of head and neck radiological imaging is to assess the exact extent of disease including evaluation of size, location, extent of tumour, infiltration into surrounding vascular and visceral structures and nodal staging and to precisely define their location by a standard classification system that can be understood and consistently applied by radiologist, surgeon, radiation oncologist and pathologist. With the advent of cross-sectional imaging, the anatomy of neck is better understood and evaluated. CT is non-invasive, non-operator dependent , allows for precise measurements of tissue attenuation coefficients and offers good delineation of fat from other tissues. Multiplanar reconstructions can be obtained in any preferred plane. Additionally, CT is less susceptible to motion artefacts, has better temporal resolution and has better compliance with claustrophobic patients as compared to MRI. Brilliant 3-dimensional imaging is achievable using volume rendering, maximum intensity projection and shaded surface display methods.*
Current study is done with the aim of assessing the role of MDCT in characterization of neck masses based on anatomical location, morphological characteristics, enhancement pattern, delineating the extent in terms of involvement of adjacent vascular and visceral structures, bone involvement and lymphadenopathy and to correlate the CT findings with histopathology.
Materials and methods: *A prospective cross-sectional study was done in 59 patients with clinically suspected neck lesions or patients who were diagnosed to have neck lesion on ultrasound and were referred for CECT neck during January 2021 to October 2022. Patients with no histopathological evaluation of the lesion were excluded. CECT was performed with GE BrightSpeed ,16 slice CT scanner. The pathological lesions were evaluated in CECT with respect to size of the lesion, location of the lesion, enhancement pattern, presence of calcification, presence of fat, extension into adjoining structures, vascular and bony involvement and the radiological diagnosis were correlated with histopathological diagnosis of the patient.*
Results: *Among 59 cases studied, 66.1 % were malignant, 20.3% were benign and 11.9% were inflammatory neck lesions.*
Prevalence of neck lesions was more in males (59.3%) and in age group of 51-60 years (23.7%). The most common neck space involved was visceral space (40.7%) followed by pharyngeal mucosal space (23.7%) and Anterior Cervical Space (13.6%).
Among the neck lesions studied, most common was pyriform fossa malignancy.
MDCT had 89.8 % accuracy in diagnosing neck lesions and 91.5% accuracy in detecting malignant lesions.
Conclusion: *MDCT has excellent accuracy in localizing and characterizing neck lesions. However, histopathology remains gold standard as CT is not 100% accurate.*
Key words : *Neck mass, CECT, Neck spaces*

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I. Introduction.

The introduction of cross-sectional imaging provides a new window in assessing structural anatomy of tissue. CT is noninvasive, non-operator dependent and allows for precise measurements of tissue attenuation coefficients. Multiplanar reconstructions can be obtained in any preferred plane with isotropic resolution. CT offers good delineation of fat from other tissues and is best for assessment of bones and calcifications.

Additionally, CT is less susceptible to motion artifacts, has better temporal resolution and has better compliance with claustrophobic patients as compared to MRI. Brilliant 3-dimensional imaging is achievable using volume rendering, maximum intensity projection and shaded surface display methods, which enables the surgeon to comprehend the anatomical extent of the lesion and its relationship to adjacent structures in a much better way (1). CT is often the first diagnostic imaging technique performed in a patient with suspected neck mass.

A mass in the neck in adults is a common entity that we customarily encounter in our clinical practice. Diagnosis of these neck masses can be challenging owing to the intricate anatomy and physiology, with a myriad of presenting complaints. Hence, it is the foremost priority of the radiologists to analyze the neck masses based on various aetiological, pathological and prognostic points of view (1,2).

Neck is a conical space situated between the base of skull and thoracic inlet divided by the hyoid bone in to a suprahyoid and infrahyoid part. Traditionally, neck used to be classified as different triangles mainly by muscles. With the advent of cross-sectional imaging, the concept of neck spaces has emerged. The neck is divided into twelve spaces by the superficial and deep cervical fascia (1).

Neck masses can be due to multiple causes classified as congenital (eg cystic hygroma), lymphadenopathy, inflammatory or neoplastic (malignant or benign). Various imaging modalities have been applied for the evaluation such as plain x-rays, contrast studies such as lymphogram, xerography and oesophagogram etc. However, these are neither sensitive nor specific in diagnosing the aetiology of neck masses [1].

The development of cross-sectional imaging techniques has substantially modified the treatment and management of neck masses [1].

Spiral CT is standard for imaging neck tumours. Multislice CT scan is advantageous in defining the critical relationships of tumour and lymph node metastases and for functional imaging of the hypopharynx and larynx both in transverse and coronal planes (2). The purpose of head and neck radiological imaging is to assess the exact extent of disease which would aid in determining the best surgical and therapeutic requirement and strategy. The process of assessment includes evaluation of size, location and extent of tumour, infiltration into surrounding vascular and visceral structures and nodal staging and to precisely define their location by a standard classification system that can be understood and consistently applied by radiologist, surgeon, radiation oncologist and pathologist (2). CT with its unique capacity to display osseous and soft tissue details has become an indispensable tool in the evaluation of patients with a neck mass. The trans axial orientation of CT planes are particularly useful in certain locations such as pterygopalatine fossa.

Though CT and MRI are highly helpful in the evaluation of spaces of head and neck, both have its own limitations. Higher soft tissue contrast resolution, lack of need of iodine-based contrast agents and high sensitivity for detecting intracranial and perineural lesions and diseases are the merits of MRI while lower patient tolerance, contraindication with implanted metallic devices and pacemakers, artefacts related to multiple causes and not the least of which is in motion are its demerits. CT is a fast, well tolerated and readily accessible and feasible modality but has lower tissue contrast resolution and involves iodinated contrast and ionizing radiations (2).

Current study is done with the aim of assessing the role of MDCT in characterization of neck masses based on location, morphological characteristics, enhancement pattern, delineating the extent in terms of involvement of adjacent vascular and visceral structures, bone involvement and lymphadenopathy and to correlate the CT findings with histopathology.

II. Materials and methods

This prospective cross sectional study was done on patients who attended Yenepoya Medical College Hospital,Mangalore from September 2020 to October 2022, who met the inclusion and exclusion criteria.

Study Design: Prospective study- Cross sectional study.

Study location : Department of Radio diagnosis in Yenepoya Medical College Hospital, Mangalore.

Study duration : September 2020 to October 2022

Sample Size : 59

Sample Size Calculation :The sample size was calculated using G* Power software.

According to a study conducted in Gujarat Cancer Research Institute, Gujarat by Dr.Saumil Desai and Dr.Darshan Thummar,the sensitivity rate in assessment of neck mass by MDCT in comparison with HPE was 95.7% considering level of significance at 5% and study precision at 5%.
Hence, the sample size was calculated.
The sample size estimated for the present study will be n= 59

Subjects and selection method: This study was conducted in yenepoya medical college in patients with clinically suspected neck lesions or patients who were diagnosed to have neck lesion on ultrasound and were referred to CT. All patients were scanned in the GE BrightSpeed ,16 slice CT scanner. A total number of 59 patients were included in the study.

Inclusion criteria:
1. Patients with suspected neck mass.
2. Patients in whom a neck lesion was detected on ultrasound study.

Exclusion criteria:
1. Patients with history of trauma related neck swelling.
2. Patients with contraindications to contrast administration like contrast hypersensitivity or high renal parameters.
3. Pregnant patients.
4. Patients with history of surgeries which alters the anatomy of neck.
5. Patients who deny consent.
6. Patients with no HPE.

Procedure methodology

Approval of the Institutional ethics committee was taken before conducting the study. The study was conducted in accordance with the ethical norms as laid down in the Declaration of Helsinki. Strict confidentiality of the information collected was maintained. All the data was saved in a private laptop which was password protected.

Only researchers and guides had access to the data. The participants were explained about the nature andpurpose of this study. Written informed consent were obtained prior to data collection.

This study was conducted in yenepoya medical college in patients with clinically suspected neck lesions or patients who were diagnosed to have neck lesion on ultrasound and were referred to CT. All patients were scanned in the GE BrightSpeed ,16 slice CT scanner. A total number of 59 patients were included in the study.

Patients were kept nil per oral 4 hours prior to CT scan to avoid complications while administering contrast medium. Risk of contrast administration were explained to the patient and consent was taken prior to the contrast study. Routine lateral tomogram of the neck was taken in all patients in supine position with head in extended position. Axial plain sections were taken using 5 mm sections from the base of skull to thoracic inlet, and reconstructed to 1.25 mm sections. In all patients, Plain study was followed by contrast study using 5 mm sections and reconstructions to 1.25 mm thinner sections. Contrast study was done using IV contrast Iohexol(Contrapaque 350) 1 ml per kg body weight and images were taken in arterial and venous phase.

Newer techniques such as maximum intensity projections and Minimum intensity projections were done as and when necessary. Scans will be reviewed in appropriate windows like mediastinal window, laryngeal window andbone window.

The pathological lesions will be evaluated with respect to the 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 statistics, sensitivity and specificity analysis will be done using ROC curve.

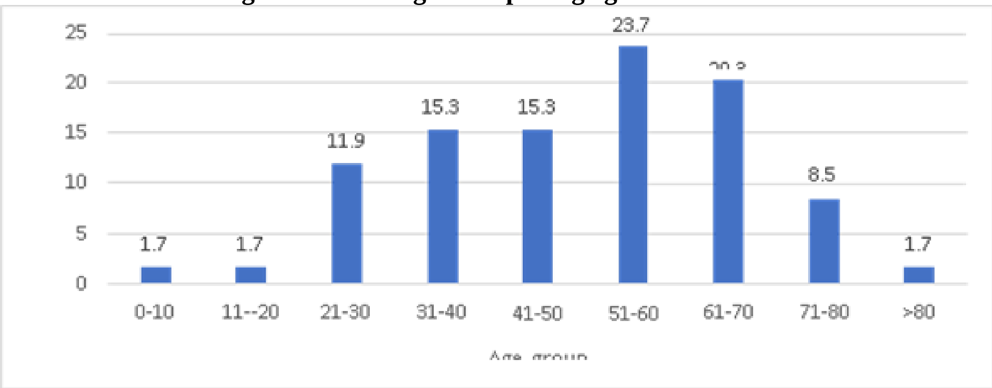
III. Results

Table 1: GENDER DISTRIBUTION OF STUDY PARTICIPANTS (N = 59).

Gender	Frequency (n=59)	Percentage
Female	24	40.7
Male	35	59.3

Out of the total 59 study participants, 24 (40.7%) were females and remaining (59.3%) were males.

Figure 1: Bar diagram depicting age distribution.



The mean age of the study participants was 49.39 years with standard deviation of 17.028 years.

Table 2: GENERAL CECT CHARACTERISTICS OF NECK LESIONS STUDIED.

		Frequency (n=59)	Percentage
Nodules	Single	41	69.5
	Multiple	18	30.5
Margins	Well defined	27	45.8
	Ill-defined	32	54.2
Calcification	Present	46	78.0
	Absent	13	22.0
Enhancement	Enhancing	52	88.1
	Non enhancing	7	11.9
Adjacent organinvasion	Absent	48	81.4
	Present	11	18.6
Vascular invasion	Absent	58	98.3
	Present	1	1.7
Bone invasion	Absent	56	94.9
	Present	3	5.1
Lymph node	Absent	27	45.8
	Present	32	54.2

Out of total, most (69.5%) of the lesions were solitary and 54.2% had ill-defined margins. Adjacent organ invasion was seen in 18% of the cases.3 cases showed bone invasion ,whereas only 1 of the lesions showed adjacent vascular invasion.

Figure 2: Pie chart depicting etiology of pathologies.

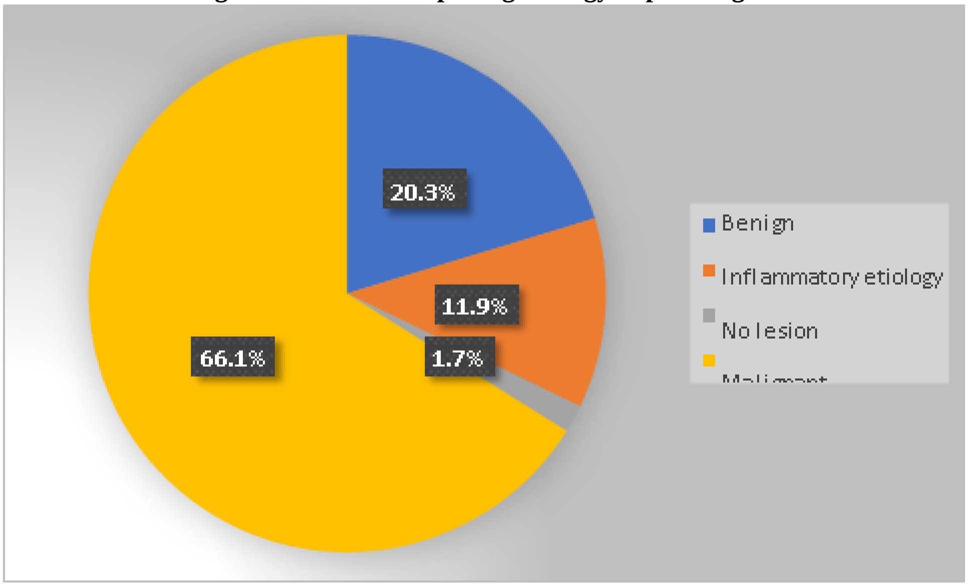
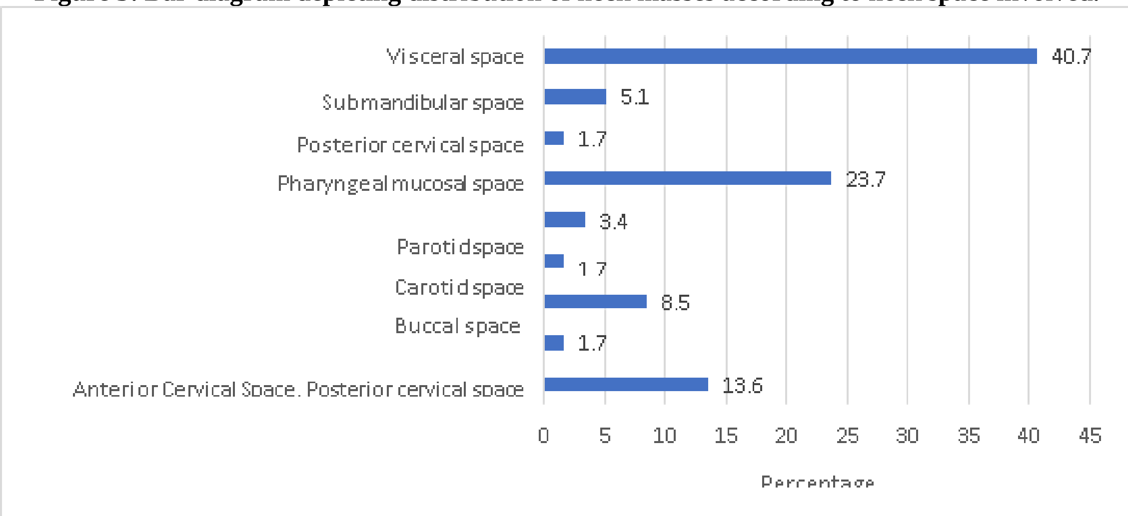


Figure 3: Bar diagram depicting distribution of neck masses according to neck space involved.



The most common neck space involved was visceral space (40.7%) followed by pharyngeal mucosal space(23.7%) and Anterior Cervical Space (13.6%).

Table 3: SENSITIVITY AND SPECIFICITY OF CONTRAST ENHANCED MDCT IN DETECTING MALIGNANT LESIONS.

	Value	95% CI
Sensitivity	89.74%	75.78% to 97.13%
Specificity	95.00%	75.13% to 99.87%
Positive Likelihood Ratio	17.95	2.65 to 121.61
Negative Likelihood Ratio	0.11	0.04 to 0.27
Positive Predictive Value (*)	97.22%	83.78% to 99.58%
Negative Predictive Value (*)	82.61%	65.12% to 92.36%
Accuracy (*)	91.53%	81.32% to 97.19%

The accuracy of CECT in characterizing neck masses was 91.53% with sensitivity of 89.74% and specificity of95%.

Table 4: DISTRIBUTION OF NECK MASSES BASED ON ETIOLOGY ACCORDING TO NECK SPACES INVOLVED

Neck Space involved	Neck Lesions according to etiology			
	Benign neoplastic etiology	**Inflammatoryetiology**	**No lesion**	**Malignantneoplastic etiology**
Anterior Cervical Space	0	3(42.9%)	0	5(12.8%)
Anterior Cervical Space, Posterior cervical space	0	0	0	1(2.6%)
Buccal space	0	0	0	5(12.8%)
Carotid space	1(8.3%)	0	0	0
Parotid space	1(8.3%)	0	0	1(2.6%)
Pharyngeal mucosal space	0	1(14.3%)	0	13(33.3%)
Posterior cervical space	0	0	0	1(2.6%)
Submandibular space	0	3(42.9%)	0	0
Visceral space	10(83.3%)	0	1(100%)	13(33.3%)

Among malignant lesions, most of the lesions were located in the visceral space and pharyngeal mucosal space.Among benign neoplastic lesions, most of the lesions were seen in the visceral space .

Table 5 : CECT CHARACTERISTICS OF BENIGN LESIONS.

Benign lesion		Frequency (n=12)	Percentage
Margins	well defined	9	75.0
	ill-defined	3	25.0
Calcification	Present	5	58.3
	Absent	7	41.7
Enhancement	Enhancing	7	58.3
	Non-enhancing	5	41.7
Adjacent organinvasion	Absent	12	100.0
	Present	_	-
Vascular invasion	Absent	12	100
	Present	-	-
Bone invasion	Absent	12	100.0
	Present	_	-
Lymph node	Absent	11	91.7
	Present	1	8.3

Table 6: CECT CHARACTERISTICS OF MALIGNANT LESIONS.

Malignant lesion		Frequency (n=39)	Percentage
Number of lesions	Single	31	79.5
	Multiple	8	20.5
Margins	Well defined	14	35.9
	Ill-defined	25	64.1
Calcification	Present	6	15.4
	Absent	33	84.6
Enhancement	Enhancing	39	100
	Non enhancing	0	0
Adjacent organinvasion	Absent	28	71.8
	Present	11	28.2
Vascular invasion	Absent	39	100
	Present	--	--

Bone invasion	Absent	36	92.3
	Present	3	7.7
Lymph node	Absent	12	30.8
	Present	27	69.2

Table 7: DISTRIBUTION OF PATHOLOGICAL DIAGNOSIS OF LESIONS ACCORDING TO THE SPACE INVOLVED.

Diagnosis	**SPACE INVOLVED**									**Total**
	Anterior Cervical Space	**Anterior Cervical Space,Posterior cervical space**	**Buccal space**	**Carotid space**	**Parotid space**	**Pharyngeal mucosal space**	**Posterior cervical space**	**Submandibular space**	**Visceral space**	
Abscess	0	0	0	0	0	1	0	0	0	**1**
Acinic cell carcinoma - parotid gland	0	0	0	0	1	0	0	0	0	**1**
Adenomatous nodular goitre	0	0	0	0	0	0	0	0	1	**1**
Branchialcyst	0	0	0	0	0	0	0	0	1	**1**
Carcinoma buccal mucosa	0	0	5	0	0	0	0	0	0	**5**
Carcinoma esophagus	0	0	0	0	0	0	0	0	2	**2**
Carcinoma hypopharynx	0	0	0	0	0	1	0	0	0	**1**
Carcinoma oropharynx	0	0	0	0	0	1	0	0	0	**1**
Carcinoma pyriform fossa	0	0	0	0	0	12	0	0	0	**12**
Carcinomavocal cord	0	0	0	0	0	0	0	0	4	**4**
Lipoma	0	0	0	0	1	0	0	0	0	**1**
Lymph nodal abscess	1	0	0	0	0	0	0	1	0	**2**
Lymphadenitis	1	0	0	0	0	0	0	0	0	**1**
Lymphadenitis with abscess formation	0	0	0	0	0	0	0	2	0	**2**
Lymphoma	2	0	0	0	0	0	0	0	0	**2**
Medullary carcinoma thyroid	0	0	0	0	0	0	0	0	1	**1**
Metastatic lymph nodes	3	0	0	0	0	0	1	0	0	**4**
Multinodular goitre	0	0	0	0	0	0	0	0	6	**6**
Necrotizing granulomato us inflammation -necrotic lymph node	1	0	0	0	0	0	0	0	0	**1**
No lesion - fibrous tissue	0	0	0	0	0	0	0	0	1	**1**
Non hodgkins lymphoma	0	1	0	0	0	0	0	0	1	**2**
Papillary carcinoma thyroid	0	0	0	0	0	0	0	0	4	**4**
Paraganglioma	0	0	0	1	0	0	0	0	0	**1**
Parathyroid adenoma	0	0	0	0	0	0	0	0	1	**1**
Solitary thyroid	0	0	0	0	0	0	0	0	1	**1**

nodule										
Total	**8**	**1**	**5**	**1**	**2**	**14**	**1**	**3**	**24**	**59**

Majority of the lesions were in the visceral space, out of which the most common lesion was multinodulargoitre. Overall ,the most common lesion found in the study was carcinoma pyriform fossa.

Table 9: DISTRIBUTION OF PATHOLOGICAL DIAGNOSIS OF BENIGN LESIONS ACCORDINGTO SPACES INVOLVED.

Neck Space involved		Diagnosis							Total
		Adenomatous nodular goitre	**Branchial cyst**	**Lipoma**	**Multi nodular goitre**	**Paragang lioma**	**Parathyroid adenoma**	**Solitary thyroid nodule**	
Benign	**Carotidspace**	0	0	0	0	1	0	0	**1**
	Parotidspace	0	0	1	0	0	0	0	**1**
	Visceral space	1	1	0	6	0	1	1	**10**
	Total	**1**	**1**	**1**	**6**	**1**	**1**	**1**	**12**

IV. Discussion

This Prospective study- Cross sectional study was conducted to evaluate the role of MDCT in characterization of neck masses and to see if MDCT findings correlated with Histopathological diagnosis. The study also calculatedthe sensitivity and specificity of MDCT in identifying malignant neck masses.

Most belongs to age group of 51 to 60 years (23.7%) followed by 61 to 70years (20.3%), 41-50 years (15.3%),

31-40 years (15.3%), 21-30 years (11.9%), 71-80 years (8.5%) and 1.7% each in the age group 0-10 years, 11-20 years and > 80years. Similar study doen by Yadav et al in 2021 showed that only 1.6% were in the age group 0- 10 years, 6.6% in 11-20 years, 10% in 21-30 years, 13.3% 31-40 years, 16.6% in 41-50years, 10% in 51-60 years 26.6% in 61-70 years and 15% in 71-80 years. Purbhe et al study showed that 6% of their study participants belonged to the age group of less than 10 years, 17% belonged to the age group 11-20years, 22% in 21-30years, 19% in 31-40 years, 11% in 41-50 years, 10% in 51-60 and 15% in more than 60 years. In Chaturvedi et al study done in 2020, 16.9% belonged to the age group of less than 40 years, 47.5% in the age group 40-50 years and 35.6% in the age group of more than 50 years. Mahajan et al study had 3% in the age group 0-10 years, 23% in 11-20 years, 44% in 21-30 years and 30% in 31-40 years. this study included only those who were 40 years or less. Mathur et al in the year 2016 had 4% of the study participants who belonged to the age group of 0-10 years, 10% each in 11-20, 21-30, 31-40 years, 16% in 41-50 years, 18% in 51-60 years, 28% in 61-70 years and 4% in 71-80 years.

Out of total, almost half (54.2%) had ill-defined margins, 78% had calcification and 88.1% had enhancement. Lymph node was seen in 54.2%, adjacent organ invasion was seen among 18.6%, 1.7% had vascular invasion and 5.1% had bone invasion. When only benign lesions were considered 58.3% had calcification, 41.7% had enhancement, 25% had ill defined margins and lymph nodes were seen only in 8.3% cases. None of the benign lesions had adjacent organ, vascular or bone invasion. Out of 39 malignant lesions, 64.1% had ill defined margins,

`15.4 % showed foci of calcifications, 28.2 % showed adjacent organ invasion and 7.7 % showed bone invasion. Regional lymphadenopathy was seen in 69.2% of the malignant lesions. All the lesions showed enhancement andvascular invasion.

In a study done by Yadav et al, 31.67% of all the lesions, 53.57% of the benign lesions and 43.75% of malignant lesions showed irregular margin. Calcification was seen in 20% of all lesions, 17.86% of benign lesions and 21.87% of malignant lesions. Enhancement was seen in 76.67%, 64.28% and 87.5% of overall, benign and malignant lesions respectively. Vasular invasion was seen in 6.67%, 3.5% and 9.37% of overall, benign and malignant lesions respectively while bone invasion was seen in 8.33% of overall lesions and 15.6% of malignant lesions. Lymph nodes were seen in 43.33% of overall lesions and 32.14% and 46.87% of benign and malignant lesions. In another study done by Purbhe et al ill defined margins were seen in 36% of overall lesions, 13.11% of benign lesions and 71.8% of malignant lesions. Enhancement was seen in 9.3% of overall lesions, 6.56% and 100% of benign and malignant lesions respectively. Soft tissue invasion was seen in 40%, 13.11% and 82.05% of overall, benign and malignant lesions respectively. Vascular invasion was seen in 3% and 7.69% while bone invasion was seen in 8% and 20.5% of overall and malignant lesions respectively.

These studies had similar finding as seen in our study where the benign lesions and malignant lesions were clearly distinguished with malignant lesions showing features such as ill defined margins, enhancement, vascular and bone invasions.

Most of the lesions in our study were malignant lesion (66.1%) followed by benign (20.3%) while lesions with inflammatory aetiology was seen in 11.9%. Similarly in study done by Yadav et al, more than half (53.3%) the lesions were malignant while 46.7% of the lesions were benign. In another study done by Chaturvedi et al 55.9%were benign lesions and malignant was 44.1%.

The common space involved in our study was visceral space (40.7%) followed by pharyngeal mucosal space (23.7%) and Anterior Cervical Space (13.6%). Mass in buccal space was seen in 8.5%, carotid space was 1.7%, parotid space was 3.4%, 1.7% in posterior cervical space and 5.1% in submandibular space.

In similar study done by Yadav et al 3.3% of the lesions involved the posterior cervical space, another 3.3% cervical space, 10% parotid space, 18.3% submandibular space, 15% buccal space and 40% were in the visceral space. Another study by Mathur et al showed lesions in visceral space (26%), submandibura space (20%), Buccal space (16%), posterior cervical space (16%), pharyngeal space (8%), carotid space (6%) and parotid space (2%).

Diagnostic accuracy of any tool can be seen by comparing its findings with that of a gold standard. Our study used histopathological findings as gold standard to see for the diagnostic accuracy of MDCT. Accuracy, sensitivity, specificity, PPV and NPV of MDCT in identifying malignant lesions as observed in different studies is given below.

All the studies had similar findings as in our study except for the study done by Chaturvedi et al which showed very low accuracy compared to that of our study.

V. Conclusion

From this study we conclude that, Contrast enhance multidetector computed tomography plays significant role in localization and characterization of neck lesions.

Accurate delineation and characterization of disease by CECT provides a reliable pre-operative diagnosis, better treatment and planning for surgery, radiotherapy ports and post treatment follow up. The most important advantage lies in its ability to detect and characterize bony lesions/invasions(erosions and expansion).

Recently developed Multidetector CT (MDCT) enables for thinner collimation with use of MPR, MIP and SSD images which improves the localization of the neck lesions.

The faster scan acquisition time, less susceptibility to deleterious artefacts from patient motion, ability to be performed in patients with implanted electrical devices are its advantages.

CT is a more practical imaging modality due to its relatively lower cost, making it more accessible to patients of lower socioeconomic strata.

Since CT is fast, well tolerated, and readily available, it can be used for initial evaluation, preoperative planning, biopsy targeting, and postoperative follow-up and reserve MRI as a complimentary imaging modality or for those tumors that may have higher chances of perineural spread.

However, histopathology still remains the gold standard as CT is not 100% accurate.

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