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CT Evaluation of Neck Masses

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Abstract: ***Background & Objectives: Neck pathologies are common ailments. For acute treatment to be given to patient accurate diagnosis of benign or malignant lesion needs to be established using imaging modalities. MDCT is widely available and relatively cheap imaging modality which can localize and characterize mass lesions. Objectives: To assess the role of contrast enhanced CT scan neck in evaluation of neck lesions: Location, morphological characteristics and enhancement pattern of neck lesions. Outline the extent and adjacent structure involvement of neck lesions. Materials and Methods: Total number of 100 patients were included in study and CECT was performed. Studies were acquired on plain scans and after nonionic contrast administration. Special attention was allotted to local tissue invasion, vascular thrombosis, bony invasion and enhancement patterns. Results: Our study showed 36 benign and 64 malignant lesions. Wherever possible the diagnosis was confirmed with help of histopathology. Post radiation necrosis was wrongly diagnosed as recurrent mass lesion in one case. Also one case which was diagnosed as benign lesion turned out to be carcinoma of buccal mucosa on histopathological analysis. MDCT showed accuracy of 97% while diagnosing lesions. Interpretation and conclusion: CT is an important and versatile tool in localizing and characterizing neck lesions and help in determining the accurate modality of treatment.***

Keywords: Neck pathologies, imaging modalities, contrast enhanced CT, Benign and malignant lesions, MDCT accuracy

1. Introduction

Since the invention of CT many advancements in protocols and techniques which has led to making it a useful tool in medical diagnosis. CT is especially useful in diagnosing neck and head lesions mainly of nasopharyngeal, skull base and laryngeal origin. CT has added a powerful tool to repertoire of clinicians.

CT provides rapid screening which makes them useful. Multiaxial images obtained on CT are especially useful in complex anatomical regions such as pterygopalatine fossa. As technology advances in the use of CT, its application in head and neck lesions hasincreased.1Neckissituated between the base of skull up to the thoracic inlet. Hyoid bone divides neck in suprahyoid and infrahyoid regions. Traditionally the neck used to be classified based on triangles[41.]With invention of cross-sectional imaging neck is now divided into various spaces. Total of twelve neck spaces have been defined which are limited and divided by superficial and deep cervical fascia.

CT with its capacity to display osseous and soft tissue details has become a useful tool in evaluation of patients with neck mass. Dynamic conventional CT is being replaced rapidly by spiral CT due to rapid acquisition of images during the study. Spiral CT is less susceptible to patient motion than conventional CT. Multiple 3D reconstructions are possible due to image acquisition in multiple planes.

Spiral CT protocol has become standard for neck imaging. Tumors of tongue base and palate and their characteristics such as midline crossing can be detected on reconstructed coronal images. Improved assessment of tumor spread and lymph node metastasis is possible in reconstructed oblique planes. Also multiplanar analysis of complex structures like larynx and hypopharynx is possible. Also due to rapid nature of image acquisition in spiral CT motion artifacts are reduces. Furthermore, full advantage of intravenous contrast agent is accomplished by optimal imaging between the injection and image acquisition.

If extensive bony destruction and invasion is noted SSD are used. Multiplanar reconstructions are obtained as additional planes to give accurate analysis. For pre-planning of surgical interventions color coded 3D reconstructions are possible. Virtual laryngoscopy also utilizes perspective rendering imaging. Multidimensional displays are used to analyze images with pathological findings in relation to anatomical structures. Thus, the radiologist can point out to the clinician the pathological findings by some essential images without having to demonstrate all axial slices.

The true purpose of neck imaging is to determine extent of disease and also best treatment modality for the disease. For this purpose accurate assessment of location, size and tumor infiltration into vascular and soft tissue structures is necessary. Also assessing and classifying and location lymph node metastasis accurately is an important part of diagnosis so as to facilitate easy of understanding of the lesion by treating and diagnosing clinician. Both CT and MRI can be used for evaluation of neck lesions but both have some advantages and disadvantages. MRI provides with higher tissue contrast, can easily diagnose perineural

invasion and intracranial disease and does not require use of iodinated contrast media which can cause anaphylactic reaction. But MRI is expensive, contraindicated in patients with pacemakers and other certain metallic implants, show multiple artifacts and show less patient tolerance. CT has lower resolution, employs ioninising radiation and iodinated contrast media but is well tolerated, fast, comparatively cheap and easily available [4.]

2. Aims and Objectives of the study

To assess the role of contrast enhanced CT scan neck in evaluation of neck lesions:

- Location, morphological characteristics and enhancement pattern of neck lesions
- Outline the extent and adjacent structure involvement of neck lesions

3. Literature Review

1) In 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 .High prevalence of malignancy in this age could be due to carcinogenic effects of tobacco ,betel chewing habit and smoking. In the present analysis male predominance of malignant lesions were detected with a male to female ratio of 3:2. Majority of malignant lesions were noted in male patients which could be explained due to the smoking and alcohol habits which are the risk factors formalignancies.
2) A study done by Abhinandan Bhattajaree (2004) showed male predilection of malignant lesions in neck. Also oropharyngeal cancer was most common malignancy followed by esophageal cancers. In their study cervical lymph nodes ranked sixth and laryngeal cancer ranked fifth.
3) In one series done by Reede et al (1982) also found that most common neck lesion encountered was Lymph node masses.
4) In another study by Hasan Altumbabic et al (2008) laryngeal cancers were most common (26.1%) followed by cancers of oro-pharyngeal region.
5) In a study by C.E skey et al (2000) states that necrosis is more frequently seen in malignant lesions.
6) Janakarajah et al (1984)who states that benign tumors are slow growing and show bony expansion than bony destruction whereas malignant lesions and chronic granulomatous infections show bony destruction. They also stated that intracranial and intraorbital extension is more common in malignant lesions but are also seen in infections.
7) Wang LF conducted 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.
8) 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) was100%.
9) Lazor JB et al (1994) Compared computed tomography and surgical findings in deep neck infections in
10) A 10-year retrospective study on 38 patients. In their study the false-positive rate was 13.2%, and the false-negative ratewas10.5%. The sensitivity of CT scan for diagnosis of parapharyngeal space or retropharyngeal space abscess was87.9%.
11) Holt GRet 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. CT scan accurately identified the location of the abscess in all 6 cases.
12) A study conducted by Micheal E Stoneet al (1999) on correlation of CT versus clinical findings in retropharyngeal inflammatory process in children concluded that CT was a good imaging modality with an accuracy of 73.33 % in differentiating cellulitis from abscess. In their study false positive rate was 11.4 % was and false negative rate was 14.7 %.
13) In a study done by M. Whyte et al (1989) the most common lesion is parapharyngeal space was salivary gland malignancy followed by squamous cell carcinoma metastasis and developmental lesions. Also they demonstrated different enhancement patterns for paragangliomas and schwannomas and their subsequent diagnosis.
14) A study done by PM som et al (1988) concluded that parapharyngeal space lesions, which can be distinguished on CT by evaluating not only their inherent signal characteristics but also subsequent anatomical dislocation of adjacent internal carotid artery and soft tissue planes.
15) Som PM, Biller HF(1984) did a study on surgical and CT examinations of 104 patients, each of whom presented with a parapharyngeal space mass and concluded that when dynamic scanning is used, a specific preoperative diagnosis can be made in 88% of the patients.
16) A study done by Shin K. H reviewed CT findings of 58 cases of parotid gland tumors confirmed by surgery and histopathology and were retrospectively analyzed who correctly recognized benign lesions in 38 and the CT diagnosis for malignancy was correct in 11 of 16 cases thus concluding that irregularities in tumor margin and findings of extra-glandular extension are the most helpful indicators by which benign and malignant parotid tumors may be differentiated.
17) In a study by Malard O et al (2004)in evaluating the useful fullness of computed tomography in oropharyngeal cancers they found that Sensitivity of CT for tumor extension was 82%,predictive value for bone involvement 67%. In their study they found that Clinical examination was poor in predicting the presence (54%) or absence (56%) of node involvement. Sensitivity of CT was 80%, specificity 71%, positive predictive value 67%, and negative 83%.
18) K.V Narayanaswamy et al in which 8 cases of juvenile nasopharyngeal angiofibroma were studied; all were adolescent males, and the lesion showed intense enhancement and intra cranial extension.
19) In a retrospective study by Shingaki Set al (1995) CT scanning had accuracy of 91%, a sensitivity of 86% and a specificity of 100% in the detection of nodal metastases.
20) A study done by Hansberger et al(1991)shows that

differential diagnosis of a posterior cervical mass is possible on the basis of normal contents of posterior cervical region. In their series most common lesion was metastatic lymph nodes followed by lymphomatous lymph nodes.

21) In a retrospective study by Katsantonis G.P et al (1986), the accuracy of preoperative staging by high-resolution CT. Accuracy of glottic carcinoma staging facilitated by CT was to the tune of 75%. They even showed that preoperative CT facilitated staging accuracy of supraglottic and glottic carcinomas were 91.4% and 87.5% respectively, higher than the clinical staging.
22) In a study by Zbären P, et al (1997) concluded that staging accuracy was higher if clinical and staging based on imaging is combined together. But no significant difference was noted between CT and MRI themselves
23) Wang D, Zhang W et al (2001) did a study to evaluate the usefulness of helical CT in laryngeal hypopharyngeal carcinoma and showed that Combining axial and MPR images, both the accuracy
24) in preoperative tumor staging and the diagnosis of metastatic lymph nodes were 95%. Multiple Planes reconstruction provided more information than only axial images in 23% cases.3D image displayed clearly the extension of tumor, the vessels and airway from multiple views.
25) A study by Tomura N et al (1993)used low dose CT in 32 patients to determine bony involvement. 27 out of 32 patients showed bony involvement in their study.
26) In another study by Close LG, (1986) CT diagnosed bony invasion in all (100%) patients.
27) A series by Toshiyaki take bayshi et al (2000) in their study mediated with radiological &histological pattern of bony involvement of oral cancers. They concluded that CT was extremely beneficial in re-operative evaluation of tumor spread to bone and surrounding tissues.
28) J.M. Debnam[a], A.S. Garden[b] and L.E. Ginsberg (2008)[84] states that for soft tissue ulceration occurring after radiation treatment, if there is no enhancement or clinical evidence of recurrence, itis likely benign &follow-up without biopsy seems warranted. If the ulceration is associated with adjacent enhancement, then differentiation between radiation necrosis and recurrent tumour is difficult.
29) Paul M Silverman (2005) conducted a study on MDCT lymph node imaging states that most solid masses in head and neck region are enlarged lymph nodes. They concluded that with the use of more liberal criteria, 80% of nodes will be metastatic and 20% will be benign hyperplastic.

4. Materials and Methods

Objectives of the Study

To assess the role of contrast enhanced CT scan neck in evaluation of neck masses:

a) Location, morphological characteristics and enhancement pattern of neck masses
b) Outline the extent and adjacent structure involvement of neck masses

Source of Data

Data for the study was collected from patients attending department of radio-diagnosis, PDU Medical College and Civil Hospital, Rajkot.

Method of Collection of Data

A prospective study was conducted over a period of 18 months on 100 patients with clinically suspected neck lesions or patients who were diagnosed to have neck lesion on ultrasound and were referred to CT for further characterization. Patients were evaluated with Multidetector CT (GE Bright speed 16 slice).

Provisional diagnosis was formulated on basis of CT findings and was histopathologically correlated wherever possible.

Inclusion Criteria

1) Patients with neck swelling
2) Patients with symptoms associated with neck
3) All patents with suspected neck mass.
4) Patients in whom a neck lesion was noted on any other radiological modality

Technique of the Study

Patients were kept nil orally 4 hours prior to 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 pogram 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. Following plain film acquisition contrast was administered and 4mm slices were obtained which was reconstructed to 1.5mm. Contrast study was done using 50 ml of IV contrast agent (Iohexol) and images were taken in arterial and venous phase.

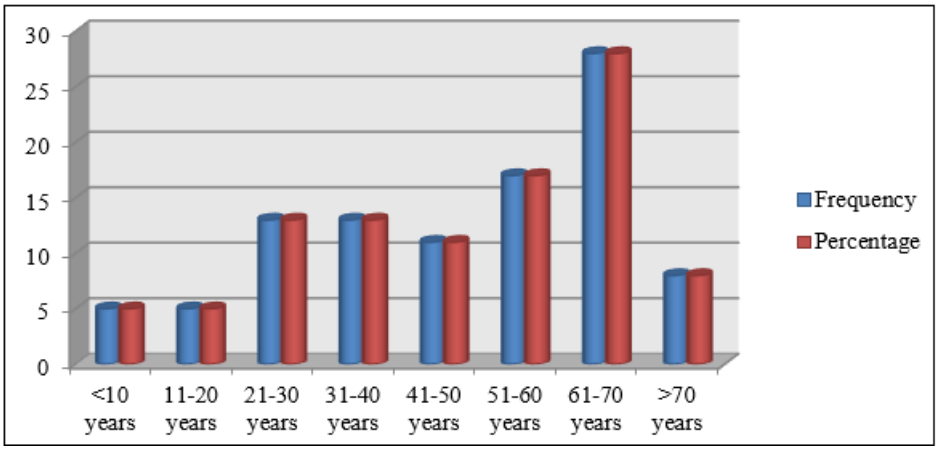
Post processing reconstructions were done using 1.5mm reconstructions. Newer techniques such as Maximum intensity projections and minimum intensity projections were done as and when necessary.

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

5. Observations and Results

Table 1: Age Distribution of Neck Masses (n=50)

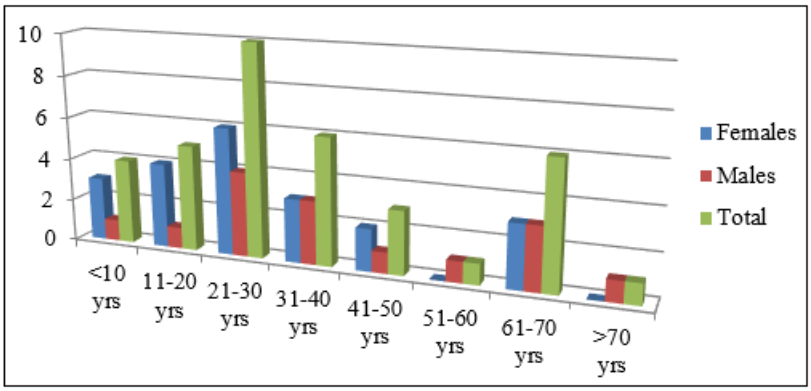
Age	Frequency	Percentage
<10 years	5	5%
11-20 yrs	5	5%
21-30 yrs	13	13%
31-40 yrs	13	13%
41-50 yrs	11	11%
51-60 yrs	17	17%
61-70 yrs	28	28%
>70 yrs	8	8%
Total	100	100%



In present analysis maximum percentage of patients were in the age group:
61-70years (28%)
51-60years (17%).

Table 3: Age and Gender Spectrum in Benign Lesion (n=36)

Age Groups (yrs)	Females	(%)	Males	(%)	Total	(%)
<10	3	9	1	3	4	11
11-20	4	11	1	3	5	14
21-30	6	17	4	11	10	29
31-40	3	9	3	9	6	17
41-50	2	6	1	3	3	9
51-60	0	0	1	3	1	3
61-70	3	9	3	9	6	14
>70	0	0	1	3	1	3
Total	21		15		36	

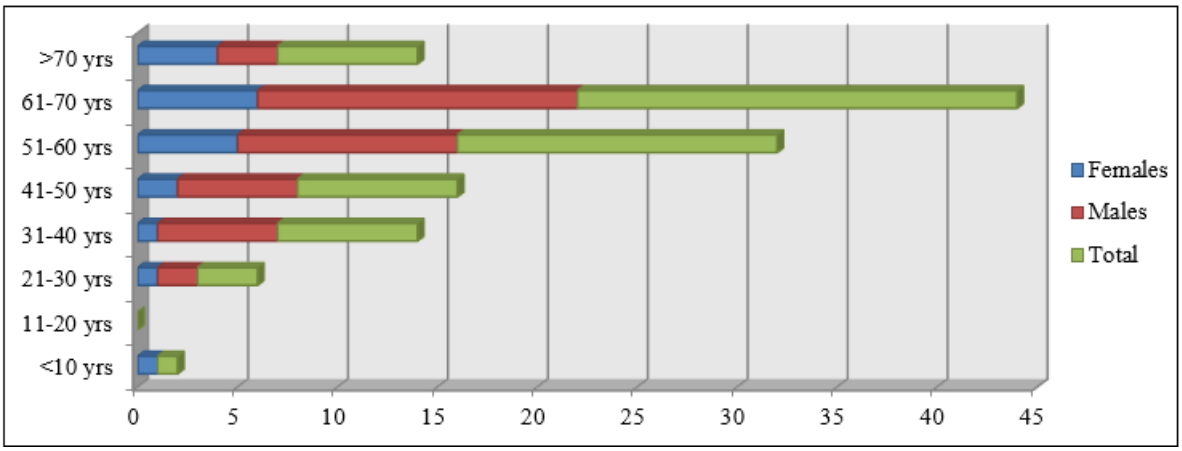


Most common benign neck mass was in the age group of 21-30 years (29%).

The present analysis shows higher incidence of benign neck mass among females with a female to male ratio of 1.33:1.

Table 4: Age and Gender Spectrum in Malignant Lesion (n=64)

Age(yrs)	Females	(%)	Males	(%)	Total	(%)
<10	1	2	0	0	1	2
11-20	0	0	0	0	0	0
21-30	1	2	2	3	3	5
31-40	1	2	6	9	7	11
41-50	2	3	6	9	8	12
51-60	5	8	11	17	16	25
61-70	6	11	16	25	22	35
>70	4	6	3	5	7	11
Total	20		44		64	



The present analysis showing higher incidence of malignant lesions between 61-70 years (35%).

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

Regarding age wise distribution of etiologies,

- Out of 100 cases studied 36(36%) were of benign etiology and 64 (64%) were malignant etiology.
- Most (76.5 %) of the benign lesions of the neck was below the age of 50years.
- Also case of post radiation necrosis73year old female was noted which was initially misdiagnosed as Tumor recurrence.
- Most of the infection (67.83%) of neck were below the age group of 40 years.
- Most (74.2%) 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
- Metastatic lymph nodes occur in age groups above fifth decade

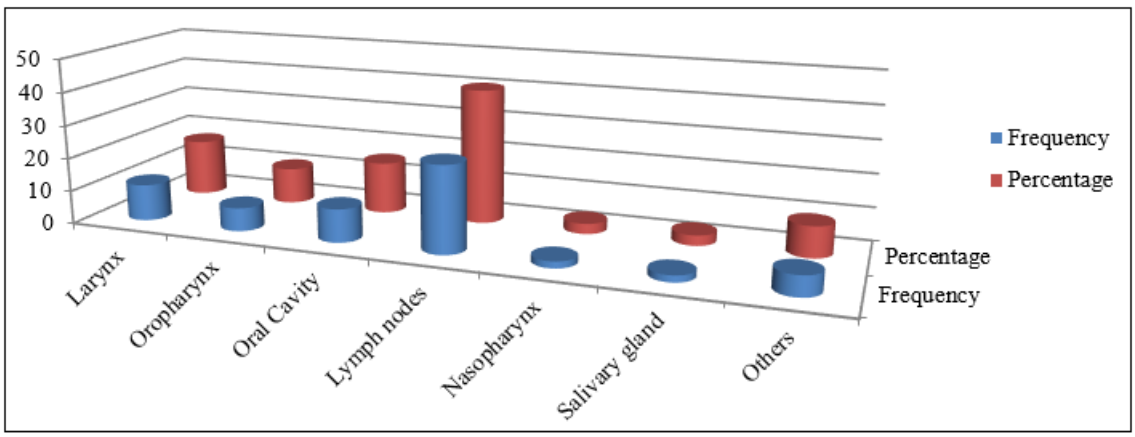
Table 6: Gender Distribution of Neck lesions (n=50)

Etiology	Total	Male	Female
Congenital	10	1	9
Infective/Inflammatory	17	11	6
Benign	9	3	6
Malignant	64	44	20
	100	59	41

In present analysis malignant lesions prevailed among male population with a male to female ratio of 2:1.
Higher incidence of all benign lesions among females was noted with female to male ratio of 1.33:1.

Table 7: Neck Organs Involved by Malignancy (n=64)

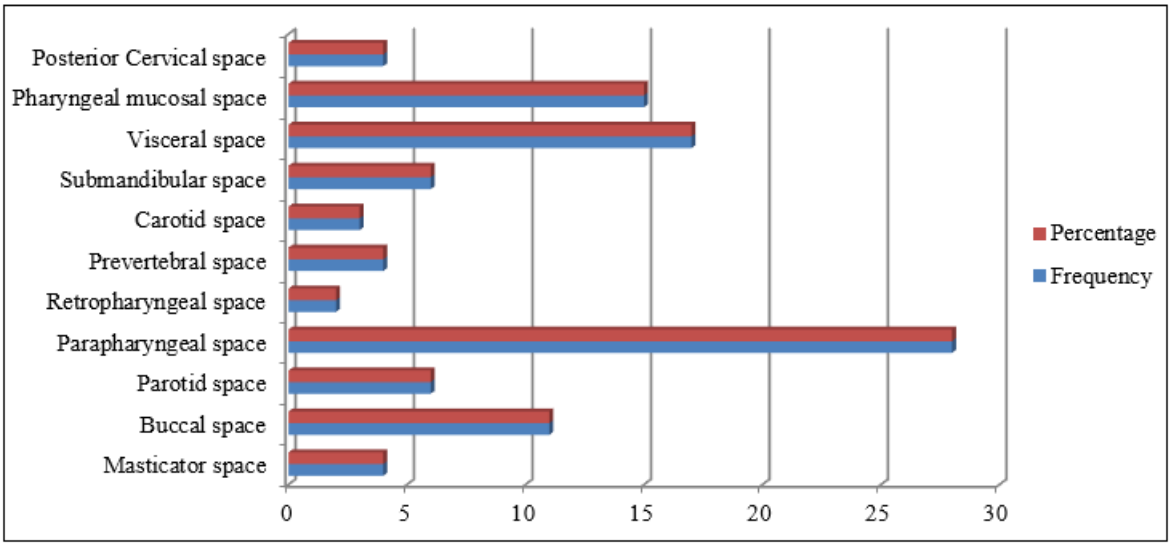
Lesion	No	%
Larynx	11	17.1%
Oropharynx	7	10.9%
Oral cavity	10	15.6%
Lymph nodes	26	40.6%
Nasopharynx	2	3.1%
Salivary gland	2	3.1%
Others	6	9.3%
Total	64	



Most common malignant lesion in my study:
(a) Metastatic lymph-nodes
(b) Laryngeal carcinoma.

Table 8: Anatomical Distribution of Neck Lesions (n=100).

Neck Space	Frequency	Percentage
Masticator space	4	4%
Buccal space	11	11%
Parotid space	6	6%
Parapharyngeal space	28	28%
Retropharyngeal space	2	2%
Prevertbral space	4	4%
Carotid space	3	3%
Submandibular space	6	6%
Visceral space	17	17%
Pharyngeal mucosal space	15	15%
Posterior cervical space	4	4%

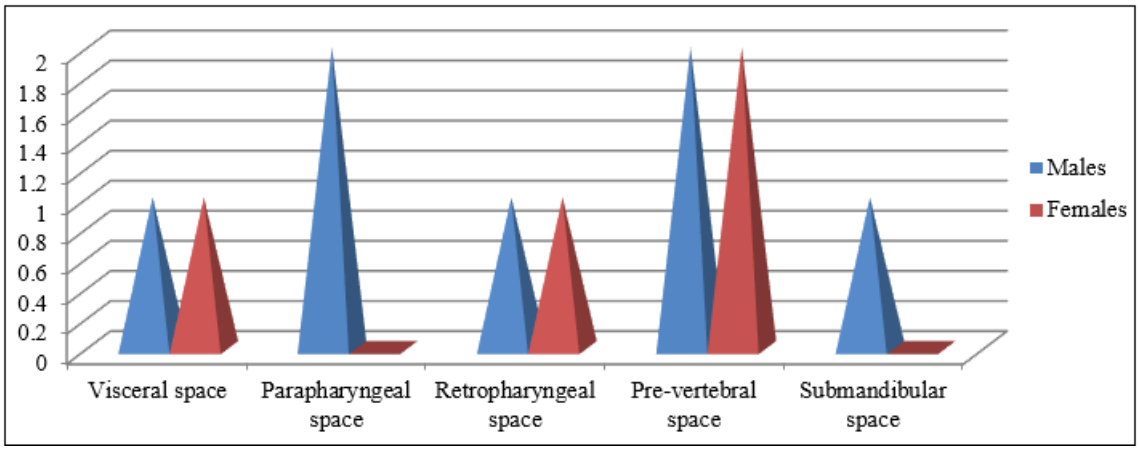


The most common lesion in my study was in:
(a) Parapharyngeal space
(b) Visceral space.

- Most (77%) of the malignant lesions demonstrated heterogeneous enhancement.
- Necrosis was present in 70.3% of the malignant lesions.
- Bony involvement was seen in 6 cases (22.2%) of the malignant lesions and in 3 (13%) cases of benign lesions.
- Vascular involvement in the form of jugular vein thrombosis was seen in 6.86% of malignant lesions.
- Extension into the adjacent space was seen in 8 (29.6%) of malignant lesions and in 6 (26.1%) cases of benign lesions.

Table 9: Neck Space Infection Incidences (n=11)

Infection	Male	Female	Percentage (%)
Visceral space	1	1	18.1
Parapharyngeal space	2	0	18.1
Retropharyngeal space	1	1	18.1
Pre-vertebral space	2	2	36.7
Submandibular space	1	0	0.9



The most common space involved was Pre-vertebral space.
There was a male preponderance with male to female ratio of 1.75:1.

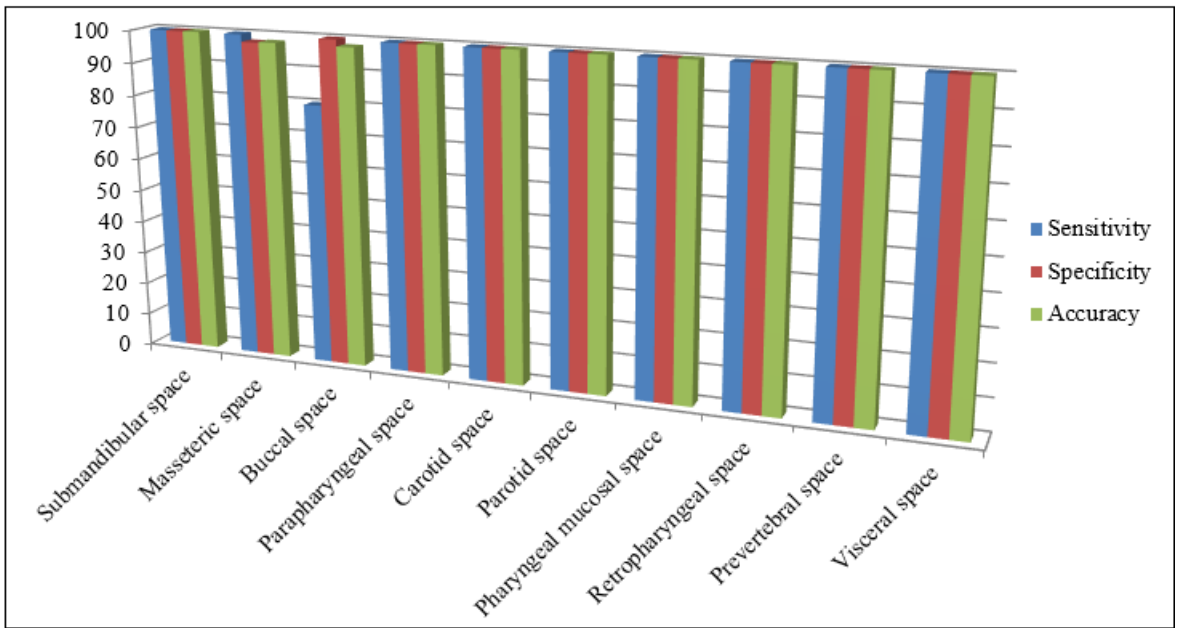
Table 11 (a): Specificity and Sensitivity Indices for Neck Lesions by CT(n=50).

Lesions according to space	Positive		Negative		Total
	True	False	False	True	
Submandibular space	6	0	0	94	100
Masticatorspace	3	1	0	96	100
Buccal space	10	0	1	89	100
Parapharyngeal space	28	0	0	72	100
Carotid space	3	0	0	97	100
Parotid space	6	0	0	94	100
Pharyngeal mucosal space	15	0	0	85	100
Retropharyngeal space	2	0	0	98	100
Prevertebral space	4	0	0	96	100
Posterior cervical space	4	0	0	96	100
Visceral space	17	0	0	83	100

In the present study 98out of 100 cases were correctly characterized by CT giving an accuracy of 98%.

Table 11 (b): Final Diagnosis Corelation for Neck Lesion by CT

Lesions according to space	Sensitivity	Specificity	PPV	NPV	Accuracy	P value
Submandibular space	100	100	100	100	100	<0.001**
Masticator 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**
Visceral space	100	100	100	100	100	<0.001**



6. Discussion

The present clinical study was conducted in hospitals attached to Department of Radio-diagnosis, PDU Medical College, Rajkot. During 18months period 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 suspected on clinical examination or other radiological investigations. Patients were evaluated with CT (GE Brightspeed). 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 and defining the extension of the lesion. The computed tomographic scans of 50 patients who were found to have lesions of neck were analyzed with available similar studies.

- Out of 100 cases studied 36(36%) were of benign etiology and 64(64%) were of malignant etiology,
- Most (76.5%) of the benign lesions of the head and neck region was below the age of 50 years.

- Most (74.2%) 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.

A study done by **Otto RA et al 61**states 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.

In another study done by **Ravimerhotra et al (2005**) **62**showed that the prevalence of head and neck malignancy was highest in patients belonging to the 50-59 years age group.

High prevalence of malignancy in this age could be due to carcinogenic effects of tobacco, betel chewing habit and smoking. In the present analysis male predominance of malignant lesions were detected with a male to female ratio of 3:2.Majority of malignant lesions were noted in male patients which could be explained due to the smoking and alcohol habits which are the risk factors formalignancies.

A study done by **Abhinandan bhattajaree (2004) 63** showed male predeliction of malignant lesions in neck.

Also oropharyngeal cancer was most common malignancy followed by oesophageal cancers. In their study cervical lymph nodes ranked sixth and laryngeal cancer ranked fifth.

Table 12: Comparison of various studies with reference to age and gender predilection for malignancies

	Gender predeliction for malignancies	Age group predilection of malignancy (years)
Ravimerhotra et al (2005)[62]	Males	50-59
Abhinandan Bhattajaree (2004)[63]	Males	-
Current study	Males	>50

The most common neck lesion in my study was lymph node 12 cases (24 %) out of which 9 were malignant lymph-node (75%) and 3 were benign nodes (25%). The most common malignant lesion in the neck in the present analysis was metastatic lymph nodes (33.3%) followed by laryngeal carcinoma (18.5%).

In one series done by **Reede et al (1982)[64]**also found that most common neck lesion encountered was Lymph node masses.

In another study by **Hasan Altumbabic et al (2008)**[93]laryngeal cancers were most common (26.1%) followed by cancers of oro-pharyngeal region.

Table 13: Comparison of various studies with reference to most common lesion of neck diagnosed on CT

	Reede et al (1982)[64]	Abhinandan bhattajaree (2004)[63]	Hasan ltumbabic et al (2008)[93]	Paul M Silverman (2005)[13]	Current study
Most common lesions	Lymph node mass	Oropharyngeal Carcinoma	Laryngeal Carcinoma	Lymph node mass	Lymph node mass
Percentage of sample size	-	-	26.1%		24%

In my study the most common space involved in the present study was parapharyngeal space (24.2%) followed by visceral space (17.8%). Necrosis was present in 70.56% of the malignant lesions. In a study by **C. Eskey et al (2000) [91]**states that necrosis is more frequently seen in malignant lesions.

In current study bony involvement was seen in 6 cases (21%) of the malignant lesions and in 3(14.5%) cases of benign lesions. The benign lesions (mandibular arterio-venousmal formations, trigeminal schwannomas, and nasopharyngeal angiofibroma) caused bony expansion and pressure deformation and remodeling rather than bony destruction or invasion. Whereas the malignant lesions (adenoid cystic carcinoma, buccal carcinoma, laryngeal carcinoma, maxillary carcinoma and nasopharyngeal 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 show bony destruction.

In current study extension into the adjacent space was seen in 8 (27.66%) of malignant lesions and in 6 (26.1%) cases of benign lesions (4 cases of abscesses, a case of nasopharyngeal angiofibroma and in case of trigeminalschwannoma). The study by **Janakarajah et al (1984)**[90] states that intracranial and intraorbital extension is more common in malignant lesions but are also seen in infections.

In this present study total of 6 deep neck space infections (1 retropharyngeal, 2 pre-vertebral ,2 visceral space and 1 sub-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 67.83 % were among males and the most common age group affected was around fourth decade (66.66%).

Wang LF[65]conducted 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.

Freling et al (2009)[66]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

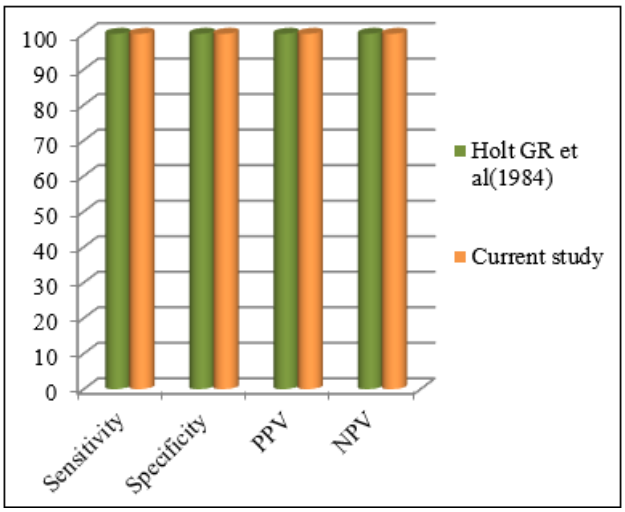
(prediction of no abscess) was100%.

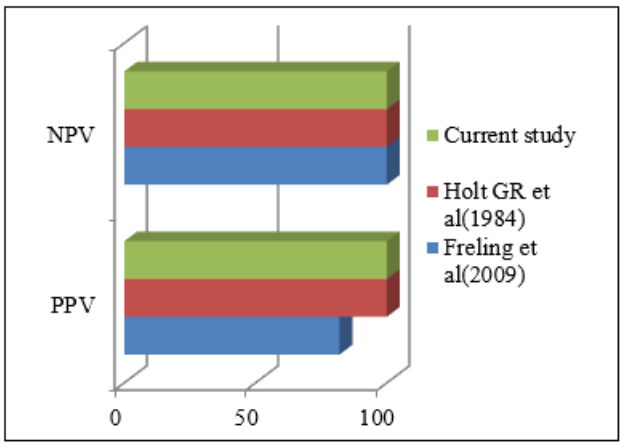
Lazor JB et al (1994)[67] Compared computed tomography and surgical findings in deep neck infections in a 10-year retrospective study on 38 patients. In their study the false-positive rate was 13.2%, and the false- negative ratewas10.5%. The sensitivity of CT scan for diagnosis of parapharyngeal space or retropharyngeal space abscess was87.9%.

Holt GRet al (1984)[68] 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. CT scan accurately identified the location of the abscess in all 6 cases.

Table 14: Comparison of various studies with reference to CT diagnosis of deep neck infections:

	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Gender Predilection	Age group predeliction
Freling et al (2009)[66]	-	-	82	100	-	-
Lazor JB et al (1994) [67]	87.9	-	-	-	-	-
Holt GRet al(1984)[68]	100	100	100	100	-	-
Wang LF[65]	-	-	-	-	Males	Mean age 41.7 years
Current Study	100	100	100	100	Males	41-50 years





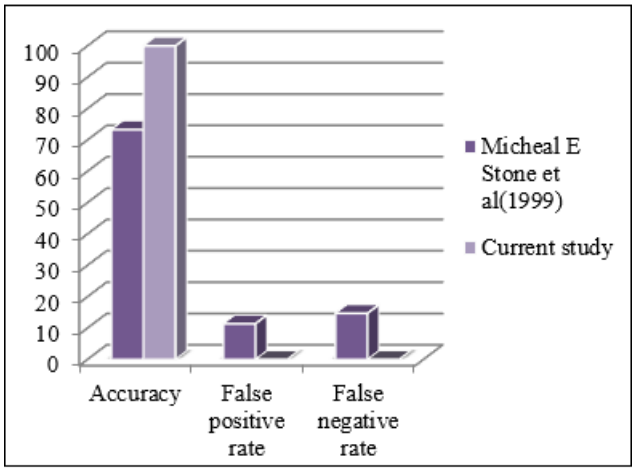
In the present study 1 case of retropharyngeal abscess was diagnosed. CT findings were able to lead to diagnosis of the lesions with sensitivity and specificity of 100% .

High PPV in present analysis may be because of lower sample size.

A study conducted by **Micheal E Stoneet al (1999)**[73] on correlation of CT versus clinical findings in retropharyngeal inflammatory process in children concluded that CT was a good imaging modality with an accuracy of 73.33 % in differentiating cellulitis from abscess. In their study false positive rate was 11.4 % was and false negative rate was 14.7 %.

Table 15: Comparison of various studies with reference to CT diagnosis of retropharyngeal abscess:

	Accuracy (%)	False positive rate (%)	False negative rate (%)
Micheal E Stoneet al (1999)[73]	73.33	11.4	14.7
Current study	100	0	0



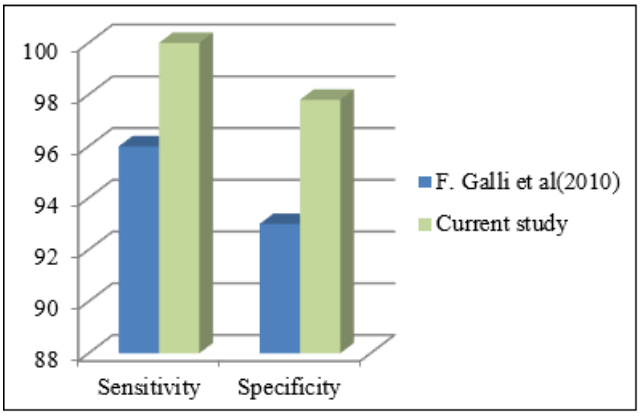
Higher sensitivity and specificity in this study could be because of smaller sample size.

In present analysis two cases showed primary masticator space involvement (mandibular arteriovenous malformation and mesenteric hemangioma) and three others showed secondary invasion of the space from adjacent spaces bringing the total to 5 cases. The sensitivity and specificity of masticator space lesions were 100% and 97.8% respectively and positive predictive value is 80% and accuracy of 98%. 1 Case of post radiation necrosis was misdiagnosed as tumor recurrence.

A study done by **F. galli et al (2010)**[21]correctly identified the space in 96% of the lesions and characterized the lesions in 93 % of cases.

Table 16: Comparison of various studies with reference to CT diagnosis of masticator space lesions

	Sensitivity (%)	Specificity (%)
F.galli et al (2010)[21]	96	93
Current study	100	97.8

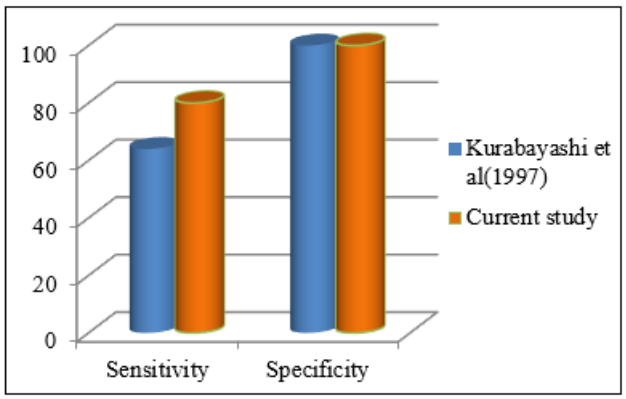


In the present study 5 cases of buccal space lesions were encountered wherein CT accurately diagnosed 4 out of 5 cases with a sensitivity of 80%, specificity of 100 % and accuracy of 98%. One case was mis- diagnosed as benign and histopathologically proven as malignant.

In a study done by **Kurabayashi et al (1997)**[27]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 concluded that CT was useful in demonstrating the presence and location of the mass in buccal space.

Table 17: Comparison of various studies with reference to CT diagnosis of buccal space lesions:

	Sensitivity (%)	Specificity (%)
Kurabayashi et al (1997)[27]	64	100
Current study	80	100



In the present analysis12 cases of prestyloid parapharyngeal masses and3 cases of retrostyloid (carotid space) were diagnosed. Out of 15 eight (53.47%) were lymph-node mass both reactive (1) and metastatic lymph-nodes (7). Cases of branchial cleft cysts (2) and cases of lymphangiomas (2) were encountered in study. Cases of vagal schwannoma (2) and case of paraganglioma (1) were encountered CT findings were able to lead to diagnosis of the lesions in 14 out of 14 cases with a sensitivity and specificity of 100%.

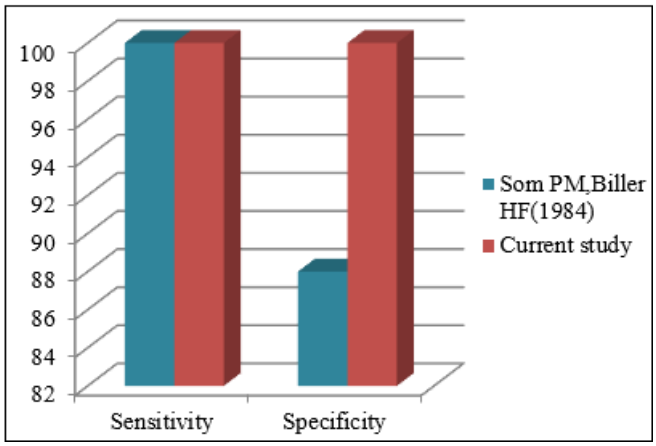
In a study done by **M. Whyte et al (1989)**[70]the most common lesion is parapharyngeal space was salivary gland malignancy followed by squamous cell carcinoma metastasis and developmental lesions. Also they demonstrated different enhancement patterns for paragangliomas and schwannomas and their subsequent diagnosis.

A study done by **PM som et al (1988)** [48]concluded that parapharyngeal space lesions, which can be distinguished on CT by evaluating not only their inherent signal characteristics but also subsequent anatomical dislocation of adjacent internal carotid artery and soft tissue planes.

Som PM, Biller HF(1984) [49]did a study on surgical and CT examinations of 104 patients, each of whom presented with a parapharyngeal space mass and concluded that when dynamic scanning is used, a specific preoperative diagnosis can be made in 88% of the patients.

Table 18: Comparison of various studies with reference to CT diagnosis of parapharyngeal space lesions

	Sensitivity (%)	Specificity (%)
Som PM, Biller HF(1984) [49]	100	88
Current study	100	100



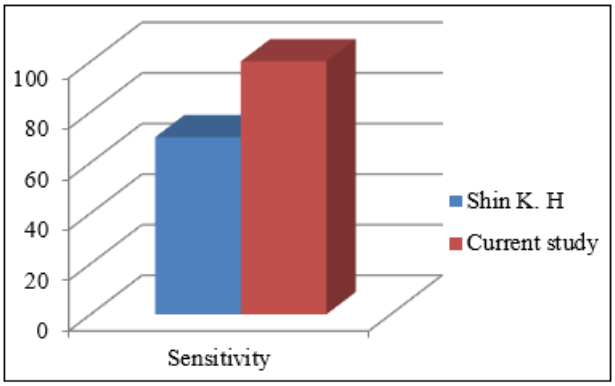
In present analysis3 cases of parotid lesions were encountered, 1 case of pleomorphic adenoma, 1case of adenoid cystic carcinoma and a case of intraparotid lymphnode. CT findings were able to lead to diagnosis of the lesions in all the 3 cases with sensitivity and specificity of 100%.

A study done by **Shin K. H**[71]reviewed CT findings of 58 cases of parotid gland tumors confirmed by surgery and histopathology and were retrospectively analyzed who correctly recognized benign lesions in 38 and the CT diagnosis for malignancy was correct in 11 of 16 cases thus concluding that irregularities in tumor margin and findings of extra-glandular extension are the most helpful indicators by which benign and malignant parotid tumors may be differentiated.

Table 19: Comparison of various studies with reference to CT diagnosis of parotid lesions

	Sensitivity of CT to diagnose malignant lesion (%)
Shin K. H[71]	70

Current study	100



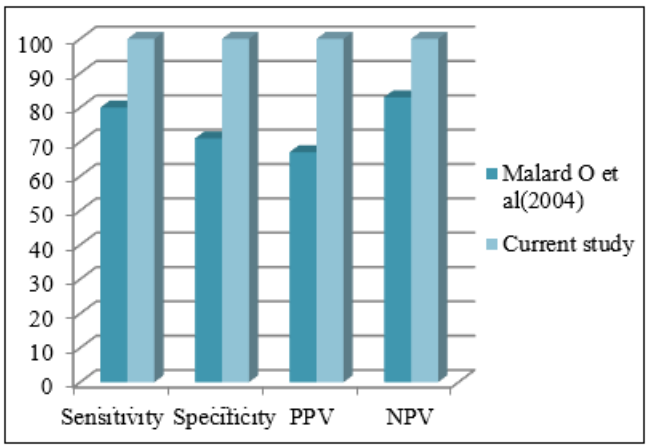
Higher values in current study may be attributed to low sample size.

In the present analysis5 cases of pharyngeal mucosal lesions were diagnosed. 1 case of adenoid hypertrophy, 1 case of juvenile angiofibroma, 1 case of nasopharyngeal carcinoma,1 case of tonsillar carcinoma and 1 case of base of tongue carcinoma. CT findings were able to lead to diagnosis of the lesions in all 5 patients with sensitivity and specificity of 100%.

In a study by **Malard O et al (2004)**[89]in evaluating the useful fullness of computed tomography in oropharyngeal cancers they found that Sensitivity of CT for tumor extension was 82%, predictive value for bone involvement 67%. In their study they found that Clinical examination was poor in predicting the presence (54%) or absence (56%) of node involvement. Sensitivity of CT was 80%, specificity 71%, positive predictive value 67%, and negative 83%.

Table 20: Comparison of various studies with reference to CT diagnosis of Oropharyngeal mucosal lesions:

	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Malard Oet al (2004)[89]	80	71	67	83
Current study	100	100	100	100



In our study higher sensitivity and specificity could be attributed to lower sample size.

In present analysis, 1 case of nasopharyngeal angiofibroma was diagnosed in young adolescent male involving the pterygopalatine fissure and the nasopharynx and local invasion into ethmoid sinuses with intracranial extension with intense vascular enhancement on contrast administration. This is comparable with study by **K.V Narayanaswamy et al**, [72]in which 8 cases of juvenile nasopharyngeal angiofibroma were studied; all were adolescent males, and the lesion showed intense enhancement and intra cranial extension.

Table 21: Comparison of various studies with reference to CT diagnosis of nasopharyngeal angiofibroma:

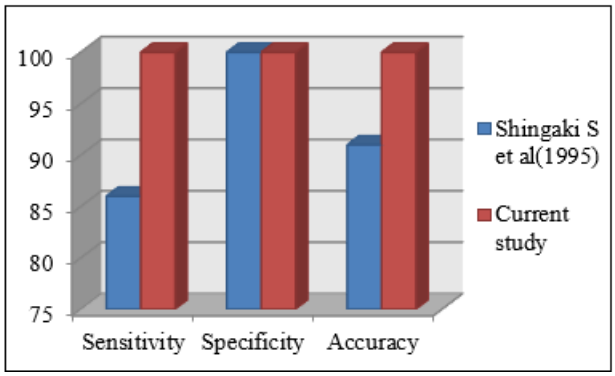
	Gender Predilection	Contrast enhancement	Intracranial extension
K.V Narayanaswamy et al, [72]	Males	Intense Enhancement	Present
Current study	Males	Intense Enhancement	Present

In present analysis, a total of 12 lymph-nodes (one intraparotid node, one submandibular node, two posterior cervical nodes and eight parapharyngeal) were diagnosed of which3werebenign and9 were malignant. Based on size criteria and central necrotic area CT findings were able to lead to correct diagnosis of the nodes with 100 % sensitivity and specificity and an accuracy of 100%.

In a retrospective study by **Shingaki Set al (1995)**[74] CT scanning had accuracy of 91%, a sensitivity of 86% and a specificity of 100% in the detection of nodal metastases.

Table 22: Comparison of various studies with reference to CT diagnosis of lymph node lesions:

	Sensitivity (%)	Specificity (%)	Accuracy (%)
Shingaki S et al (1995)[74]	86	100	91
Current study	100	100	100



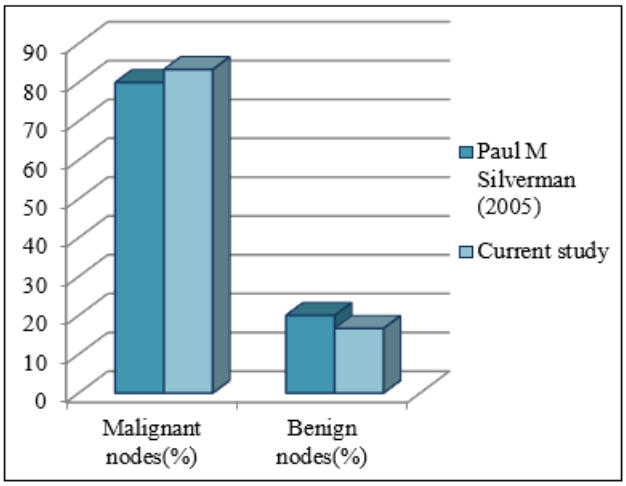
Higher sensitivity and specificity in our study could be attributed to the lower sample size in this study.

In another study by **Steinkamp H J et al (1994)**[15]in cervical lymph-node metastasis using spiral CT had an accuracy of 96% and they concluded that spiral CT is highly accurate to differentiate the metastatic lymph node from inflammatory nodes. Also ***Paul M Silverman (2005)***concluded that80% of nodes are malignant and 20% are benign hyperplastic[13].

Table 23: Comparison of various studies with reference to malignant vs benign lymph nodes:

	Malignant Nodes (%)	Benign Nodes (%)

Paul M Silverman (2005)	80	20
Current study	83.33	16.66



In present analysis 2 cases of posterior cervical lymph nodes were detected. CT was able to localize lymph-nodes accurately in both the cases and correctly characterize the lymph- nodes in both the cases.

A study done by **Hansberger et al (1991)**[52]shows that differential diagnosis of a posterior cervical mass is possible on the basis of normal contents of posterior cervical region. In their series' most common lesion was metastatic lymph nodes followed by lymphomatous lymph nodes.

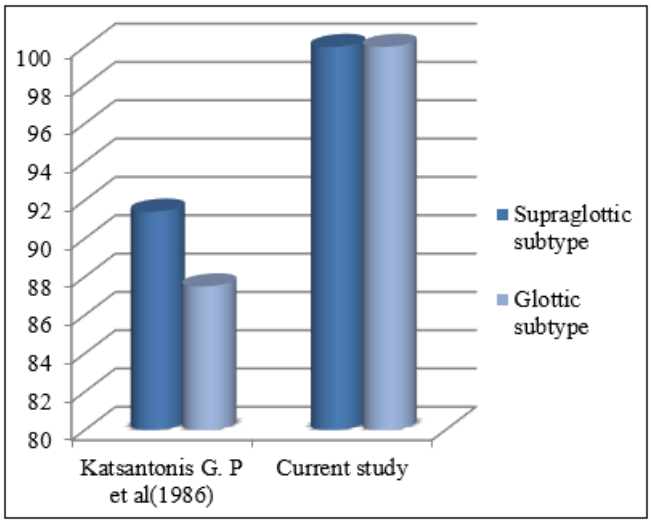
In the present analysis6 cases of laryngeal carcinomas (4 glottic carcinomas and 2 supraglottic carcinomas) were encountered. CT findings were able to lead to diagnosis of the lesions with 100 % sensitivity and specificity.

In a retrospective study by **Katsantonis G.P et al (1986)**[75], the accuracy of preoperative staging by high-resolution CT. Accuracy of glottic carcinoma staging facilitated by CT was to the tune of 75%.

They even showed that preoperative CT facilitated staging accuracy of supraglottic and glottic carcinomas were 91.4% and 87.5% respectively, higher than the clinical staging. Higher accuracy of laryngeal carcinoma in our analysis could be because of the use of Spiral CT and lower sample size in this study.

Table 24: Comparison of various studies with reference to accuracy of CT diagnosis of laryngeal lesions

	Supraglottic subtype (%)	Glottic subtype (%)
Katsantonis G.P et al (1986)[75]	91.4	87.5
Current Study	100	100



In a study by **Zbären P, et al (1997)**[76] concluded **that** staging accuracy was higher if clinical and staging based on imaging is combined together. But no significant difference was noted between CT and MRI themselves.

Keberle M, Sandstede J, et al (2003)[77]conductedastudy toevaluate3d multiplanar reconstructions in staging of laryngeal and hypopharyngeal carcinomas and concluded that coronal and sagittal planar reconstructions provided a better diagnosis of the tumor in 14 of 42 (33 %) of the patients.

It also influenced the patient management in 8 of 42 (19 %) of the patients and showed conclusively that besides the 3-mm axial slices, coronal and sagittal multiplanar reconstructions can improve the identification of laryngo-pharyngeal tumors and are recommended for preoperative MSCT of laryngeal and/or hypo pharyngeal carcinomas.

Wang D. Zhang W et al. (2001)[78] did a study to evaluate the usefulness of helical CT in laryngeal and hypopharyngeal carcinoma and showed that Combining axial and MPR images, both the accuracy in preoperative tumor staging and the diagnosis of metastatic lymph nodes were 95%. Multiple planes reconstruction provided more information than only axial images in 23% cases.3D image displayed clearly the extension of tumor, the vessels and airway from multiple views.

In present analysis 1 case of thyroid malignancy was encountered which was correctly diagnosed 1case of parathyroid adenoma was encountered in present analysis where CT findings were able to lead to diagnosis of the lesions with sensitivity and specificity of 100%.

Bone/ Cartilaginous involvement

In present analysis, 1case of mandibular Arteriovenous malformation, which was seen in18 year old female patient who presented with jaw swelling. There large ill-defined involvement of left hemi-mandible causing expansion of the outer and inner cortices of left hemi-mandible causing hemi-mandibular hypertrophy.

Other patients showed bony involvement secondary to maxillary carcinoma, nasopharyngeal angiofibroma, buccal

carcinoma and a case of nasopharyngeal carcinoma.

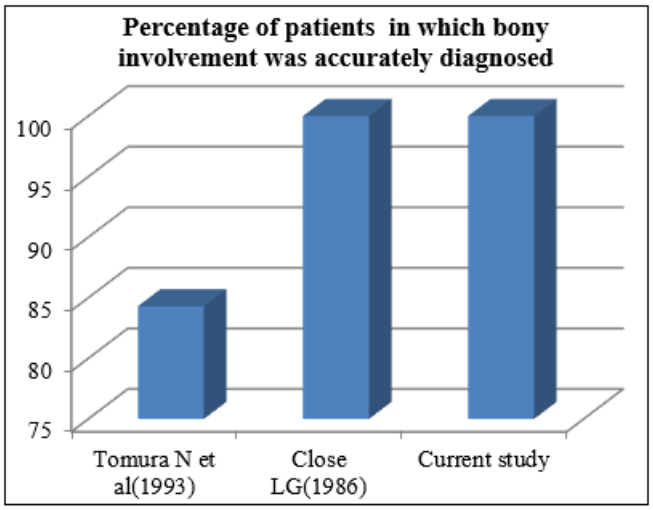
In present analysis CT was able to diagnose bony involvement in all cases where it was present. Malignant lesions caused bony erosions and bony invasions whereas benign lesions caused cortical expansion without bony erosions.

A study by **Tomura N et al** (**1993**) used low dose CT in 32 patients to determine bony involvement. 27 out of 32 patients showed bony involvement in their study.

In another study by **Close LG, (1986**) CT diagnosed bony invasion in all (100%) patients.

Table 25: Comparison of various studies with reference to CT diagnosis of bony involvement:

	Tomura N et al (1993)[79]	Close LG, (1986) [8o]	Current study
Percentage of patients in which bony involvement was accurately diagnosed (%)	84.3	100	100



A series by **Toshiyaki takebayshi et al (2000)** in their study mediated with radiological & histological pattern of bony involvement of oral cancers. They concluded that CT was extremely beneficial in re-operative evaluation of tumor spread to bone and surrounding tissues.

Bone Involvement
In the present study CT was able to diagnose bony invasion, erosion and destruction in all the cases which provides a definite niche over MRI with respect to diagnosing bony involvement. With regard to individual etiologies there was an overall accuracy of 97% accuracy in diagnosing neck lesions. One false positive case which we encountered in this analysis was a case of post radiation necrosis which was misdiagnosed as tumor recurrence. There was enhancement of the lesion and hence was wrongly diagnosed as tumor recurrence but was histologically proven to be necrosis.

J.M. Debnam[a], A.S. Garden[b] and L.E. Ginsberg (2008)[84] states that for soft tissue ulceration occurring after radiation treatment, if there is no enhancement or clinical evidence of recurrence, it is likely benign & follow-up without biopsy seems warranted. If the ulceration is associated with adjacent enhancement, then differentiation between radiation necrosis and recurrent tumor is difficult.

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.

T. Kurabayashi et al (1997)[28]reported that when ill-defined margins, violation of fascia and aggressive bone destruction wereused as the criteria for the malignancy, only seven out of 11 malignant tumors were correctly diagnosed (sensitivity 64%). However, they concluded that CT is of limited value when differentiating benign buccal mucosa lesion from malignant buccal mucosa lesion and should be confirmed histopathological

Conclusion

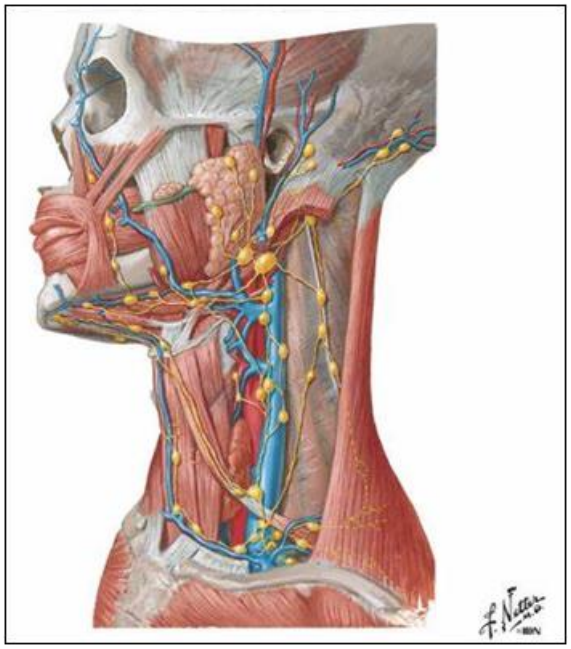
- From the current analysis we affirm that CT has improved diagnostic confidence as well as spatial localization of neck masses.
- Accurate delineation of disease by CT scan provides a reliable pre-operative diagnosis, planfor radiotherapy ports and post treatment follow up.
- Bony invasion and involvement is most readily detected in CT
- MDCT employs usage of multi-planar reconstructions, and SSD for more effective and precise anatomical localization of neck masses
- The rate of image acquisition is very high in CT thus reducing many motion artifacts thus promoting superior diagnosis.
- CT is easily available at a much lower cost when compared to most other imaging modalities making it one of the first radiological investigations in many cases
- Since CT is fast, well tolerated, and readily available CT, 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 higher chance of perineural spread.
- However, histopathology still remains the gold stndard as CT is not 100%accurate

Summary

- Among 100 cases studied 36(36%) were benign and 64(64%) were malignant neck lesions.
- Overall there was a male preponderance with 59(59%) males and 41(41%) females and with a male to female ratio of 3:2.
- Among the neck lesions the most common was Lymph-node mass (40.6%) followed by laryngeal carcinoma (17.1%) and oral cavity malignancy (15.6).
- Benign lesion was common in the age group of 21-30 with a female to male ratio of1.33:1.
- 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 parapharyngeal space (28%) followed by visceral space (17%).
- CT has 98% accuracy in diagnosing neck lesions.
- CT has 100 % accuracy in predicting bony involvement

in head and neck cancers.

- Advantages of CT includes ability to perform thin slice scanning with thinner reconstruction intervals and ability to perform MIP, SSD, MPR and curved reformatted images.
- Thus, CT has an excellent accuracy in localizing and characterizing of the neck lesions.



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