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Carcinoma Larynx:the Role of Ct Scan in Diagnosis and Staging (A Study of 50 Cases)

KEYWORDS: carcinoma , larynx , CT scan

Dr Shivam M Jani
3rd year resident, department of radiology, V S Hospital

Dr Chhaya J Bhatt
Professor, department of radiology, V S Hospital

ABSTRACT *Laryngeal carcinoma accounts for 1% of all cancers 95% of all being squamous cell carcinoma. Modalities available for diagnosis and staging are clinical examination, direct and indirect scopy, biopsy and histopathological examination, CT and MRI. CT is the standard imaging modality for evaluation of carcinoma of larynx because of its easy availability, inherently high spatial resolution, faster acquisition time and recent advances like MDCT.*

AIMS AND OBJECTIVES: *To determine accuracy of CT scan in diagnosing and detecting spread,cartilage invasion and lymphnodal metastases of laryngeal carcinoma and comparing it with histopathological findings.*

MATERIALS AND METHODS: *A prospective observational study of 50 cases of either suspected or scopy/biopsy proven laryngeal carcinoma were evaluated with CT scan and the findings were than compared with per-operative or histopathological findings.*

CONCLUSION: *Cross sectional imaging like CT is important and most widely used modality to delineate the extent of primary ,nodal spread and to evaluate deeper structures especially in endoscopically proven neoplasms with easy availability and affordability.*

INTRODUCTION:

Laryngeal carcinoma represents 1% of all cancers diagnosed. Most laryngeal malignancies are squamous cell carcinomas accounting for approximately 95% of the malignant tumours in these areas. It is potentially curable by treatment with surgery and radiotherapy both. Diagnostic and clinical staging of laryngeal carcinoma is usually performed by clinical examination, indirect and direct laryngoscopy and biopsy with histopathological examination. Direct laryngoscopy may detect mucosal lesions, however it has limited ability to define subglottic involvement, paraglottic spread and deep extension of a lesion relative to precise landmarks utilized to decide operability. The subglottic and deep extension are easily assessed by cross-sectional imaging like CT and MRI.CT is the standard imaging modality for evaluation of carcinoma of larynx because of its easy availability, inherently high spatial resolution, faster acquisition time and recent advances like MDCT.CT plays an important role in differentiating a T3 from T4 lesion as larynx sparing chemoradiation is not recommended for T4 lesion.[1]

AIMS AND OBJECTIVES:

- To determine sensitivity of CT scan in staging carcinoma of larynx with pathological / per operative findings as gold standards.
- To evaluate diagnostic accuracy of CT scan for carcinoma of larynx by comparing CT findings with operative findings.
- To evaluate accuracy of CT scan in determining laryngeal cartilage involvement in carcinoma of larynx.

MATERIALS AND METHODS:

Our study is a prospective observational study of 50 cases with no gender bias followed during the period of 8 months form February 2015 to September 2015 evaluated with CT scan for laryngeal carcinoma.The findings were compared with per-operative and histological findings.

History of hoarseness of voice, alcohol, tobacco chewing, occupation like singing or teaching was obtained.

Patient selection:

Inclusion criteria:

- All the patients referred to our department for CT scan of neck for laryngeal carcinoma diagnosed either by endoscopy or biopsy.
- The patients having positive cervical lymphnodal metastases and underwent CT neck to evaluate primary malignancy and found to have laryngeal malignancy.

Exclusion criteria:

The patients who did not give consent to enrol in this study.

The patients who had previous radiation therapy or surgery for laryngeal carcinoma.

Equipment:

The CT scan was performed using Siemens Somatom Sensation 64 slice CT scanner.

Technique:

Routine preparation required before scanning procedure includes:

- Conforming normal level of serum creatinine
- Instructing the patient to remain nil by mouth for at least 4 hours
- Asking the history of any adverse effects of contrast media

Lateral scout is obtained and slice orientation is selected parallel to laryngeal ventricle perpendicular to the axis of the spine at the level of larynx. Sequential rapid scanning with field of view corresponding to size of neck, slice thickness of 1 mm, collimation of 1 mm, 120 kVp, 180-200 mAs and pitch of 0.8. Axial slices are obtained from base of the tongue to the trachea parallel to hyoid bone.

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Plain scan is done with patient breathing quietly or breath holding and post-contrast scan is done after giving 40-60 ml of IV contrast(IOHEXOL) at the rate of 3 ml/sec by pressure injector through peripheral vein after negative test dose. Post-contrast scans are obtained after 45 seconds of contrast injection.

Scanning is done in breath holding because of the abducted position of the vocal cords which facilitates evaluation of anterior and posterior commissures. In selected patients scans were obtained with phonation or modified Valsalva manoeuvre to evaluate laryngeal ventricles.

All acquired images are reconstructed using soft tissue algorithms to obtain coronal and sagittal images and high resolution bone algorithms to evaluate for cartilage invasion by tumours.

Interpretation of the findings was done as follows:
The larynx is divided into 3 anatomic regions:

Supraglottic larynx consists of epiglottis, false vocal cords, ventricle, ary-epiglottic folds and arytenoids.

Glottic larynx consists of the true vocal cords , anterior and posterior commissures.

Subglottic larynx consists of the region between the vocal cords and the trachea. It starts 5 mm below the free margins of the vocal cords and extends caudally upto inferior aspect of cricoid cartilage.

The cartilaginous frame work of larynx consists of 9 cartilages:
Unpaired:
- Epiglottis
- Cricoid cartilage
- Thyroid cartilage

Paired:
- Corniculate cartilages
- Cuneiform cartilages
- Arytenoid cartilages

Normal CT anatomy of larynx:
The larynx is sub-divided by two theoretical axial planes , one extending through the apex of the two laryngeal ventricles and the other plane is 1 cm caudal to the first plane.

The supraglottic larynx is the portion of the larynx cranial to the first plane. The glottis is the region between two planes and includes anterior and posterior commissures. The subglottis is the region between the lower plane and inferior margin of the cricoid cartilage.

In cranial cuts the epiglottis and connecting ligaments and folds (median glossoepiglottic,pharyngoepiglottic and hyoepiglottic ligament) are seen.

More inferiorly the lateral edges of the epiglottis merge with the AE folds which in turn converge towards midline and unite posteriorly at a more caudal level.

Paraglottic space is filled with fat and portions of the hyoepiglottic ligament can be seen in midline crossing the upper portion of the fat.

False vocal cords are predominantly of fat density.

Laryngeal ventricle is slit like and is best seen on coronal images. On axial images, the location of ventricle is determined by identifying the transition from fat in the paraglottic space (supraglottis) to soft tissue in the paraglottic space (which represents the thyroarytenoid muscle).

True vocal cords can be identified by:
- Narrow and slit like airway at the level of true vocal cords
- Muscle density due to thyro-arytenoid muscle

The anterior commissure is identified by presence of air and close approximation to the cartilage.

The posterior commissure is the space between the posterior part of the vocal cords at the level of the vocal processes of the arytenoid cartilage.

The subglottis is identified as widening of airway below vocal cords becomes more oval or round shaped.

The appearance of cartilages on CT depends on the degree of ossification and amount of fatty marrow in the ossified medullary region. On CT, ossified cartilage shows a high attenuating outer and inner cortex and a central low attenuating medullary space. Nonossified cartilage has soft tissue attenuation.

Levels of cervical lymphnodes:
Level I
- below mylohyoid muscle and above the lower margin of the hyoid bone
- anterior to the posterior border of the submandibular glands

level Ia: submental nodes, i.e. between the anterior bellies of the digastric muscles

level Ib: submandibular nodes, i.e. posterolateral to the anterior belly of the digastric muscles

Level II
- internal jugular (deep cervical) chain
- base of the skull to the inferior border of hyoid bone
- anterior to the posterior border of sternocleidomastoid (SCM) muscle
- posterior to the posterior border of the submandibular glands

level IIa: anterior, lateral, or medial to the vein or posterior to the internal jugular vein and inseparable from it

level IIb: posterior to the internal jugular vein and have a fat plane separating the nodes and the vein

Level III
- internal jugular (deep cervical) chain
- lower margin of hyoid to lower margin of cricoid cartilage
- anterior to the posterior border of SCM
- lateral to the medial margin of the common carotid artery (CCA) / internal carotid artery (ICA)

Level IV
- internal jugular (deep cervical) chain
- lower margin of cricoid cartilage to level of the clavicle
- anterior and medial to an oblique line drawn through the posterior edge of SCM and the posterolateral edge of the anterior scalene muscle [4]
- lateral to the medial margin of the CCA

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Level V
- posterior triangle (spinal accessory) nodes
- level Va: superior half, posterior to levels II and III (between base of the skull and inferior border of cricoid cartilage)
- level Vb: inferior half, posterior to level IV (between the inferior border of cricoid cartilage and the level of clavicles)

Level VI
- prelaryngeal / pretracheal / Delphian node
- anterior to visceral space
- from the inferior margin of hyoid bone to the manubrium
- anterior to levels III and IV

Level VII
- superior mediastinal nodes
- between CCAs, below superior aspect of manubrium to level of the brachiocephalic vein

LARYNGEAL CANCER

Squamous cell carcinoma accounts for more than 90% of laryngeal tumors. Though it originates as a mucosal lesion, infiltration of deep spaces and laryngeal cartilage is common. Depending on the site of origin (i.e. supraglottic, glottic or subglottic) typical patterns of spread is seen.[1]

Supraglottic Carcinoma

Tumors of the epiglottis (ventral supraglottic carcinomas) primarily invade the pre-epiglottic space.Tumors that originate in the region of the petiole often invade the low pre-epiglottic space, and via the anterior commissure, the glottis or subglottis, thus becoming transglottic tumors. Tumors originating from the false cord, laryngeal ventricle or aryepiglottic fold (lateral supraglottic carcinomas) primarily infiltrate the paraglottic space.Tumors arising in the arytenoids and interarytenoid region (posterior supraglottic carcinomas) tend to infiltrate the postcricoid portion of the hypopharynx.Lymphatic spread is common; level 2/3 nodal metastases are seen.

Glottic Carcinoma

Glottic carcinoma typically arises from the anterior half of the vocal cord and primarily spreads into the anterior commissure. The anterior attachment of the true vocal cords consists of dense, avascular fibroelastic tissue that acts as a relative barrier to early glottic cancer. Once the tumor has reached the anterior commissure, it may easily spread into the supraglottis or subglottis. There is also high incidence of thyroid cartilage invasion and extralaryngeal spread through the cricothyroid membrane.

When glottic tumor spreads laterally, it eventually invades the thyroarytenoid muscle, thus leading to vocal cord fixation.

Tumor spread within the paraglottic space is limited by the conus elasticus medially and the perichondrium of the thyroid ala laterally; so further spread occurs mainly in a cephalad or caudad direction or, via the cricothyroid membrane, into the perilaryngeal tissue.

Subglottic spread is relatively common and may either occur superficial or deep to the elastic cone. Posterior extension of a glottic cancer into the anterior process of the arytenoid is relatively uncommon, and initial involvement of the posterior commissure is rare. Lymphatic metastases from glottic carcinoma are uncommon as long as the tumor is confined to the endolarynx.

Subglottic Carcinoma

Involvement of the subglottis by laryngeal cancer usually represents inferior spread of a glottic or supraglottic tumor rather than a primary tumor originating in the subglottis.

True subglottic tumors are relatively uncommon and tend to spread to the trachea or invade the thyroid gland and the cervical esophagus.

Lymph node metastases from subglottic carcinomas are much more common than from glottic carcinoma. Primary drainage is directed toward the paratracheal and pretracheal nodes.

These nodes drain to the lower jugular or upper mediastinal nodes.

Imaging interpretations:

Subglottic extension:

The normal subglottis is lined only by a thin layer of mucosa, hence any additional soft tissue is pathological.

Submucosal infiltration:

Replacement of fat in pre-epiglottic and para-glottic space with soft tissue is considered pathological.

Anterior and posterior extensions of glottic tumours:

In region of the commissures, the mucosa is directly abutting the cartilage with no submucosal tissue in between. Tumor in the anterior commissure is frequently associated with thyroid cartilage invasion or extralaryngeal extension through cricothyroid membrane. Posterior glottic tumors may invade the cricoarytenoid joint and further extend into submucosa of postcricoid pharynx.

Laryngeal cartilage invasion:

The signs of cartilage invasion on CT are:

- Extralaryngeal tumor spread
- Sclerosis
- Erosion/lysis.

Each of these CT signs corresponds to distinct histologic findings. Sclerosis corresponds to histological findings of early perichondrial invasion or microscopic intracartilaginous tumor spread inducing new bone formation. With progressive invasion, minor and major osteolysis is seen within the areas of new bone formation. Minor areas of osteolysis correspond to the CT criterion of erosion whereas major areas of osteolysis correspond to the CT criteria of lysis.

Lymphnodal metastases:

The criteria most useful for evaluating lymph node involvement are size and central necrosis. Regardless of size, if central necrosis is seen, the node is considered to be pathologic. In general, neck nodes measuring greater than 1 cm in short axis diameter are considered abnormal. However, for jugulodigastric nodes, short axis diameter greater than 1.5 cm is considered pathological.

STAGING OF CARCINOMA LARYNX

AJCC has designated staging by using the tumours , nodes and metastases (TNM) classification. Definitions for the stages are discussed below:

PRIMARY TUMOUR , T stage:

TX – indicated that the primary cannot be assessed.
T0- No evidence of primary tumour.

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Tis-indicates carcinoma in situ.

In the supraglottis, the T stages are as follows :

T1 – Tumour limited to one side subsite of supraglottis with normal vocal cord mobility.

T2- Tumour invasion of the mucosa of more than one adjacent subsite of the supraglottis or glottis or of a region outside the supraglottis (e.g. mucosa of the base of the tongue , vallecula ,medial wall of pyriform sinus) without fixation of the larynx.

T3 – Tumour limited to the larynx with vocal cord fixation and/or minor thyroid cartilage invasion (e.g. inner cortex)

T4a – Tumour invasion through the thyroid cartilage and/or invades tissues beyond the larynx (e.g. trachea , soft tissues of the neck including deep extrinsic muscle of the tongue , strap muscles , thyroid or oesophagus)

T4b – Tumour invades pre-vertebral space , encases carotid artery , or invades mediastinal structures.

Subsites include the following : false vocal cords , arytenoids , suprahyoid epiglottis , infrahyoid epiglottis and aryepiglottic folds (laryngeal aspects)

In the Glottis , the T stage are as following :

T1 – Tumour limited to the vocal cord(s) (may involve anterior or posterior commissure) with normal mobility.

T1a – tumour limited to one vocal cord

T1b – tumour involves both vocal cords

T2- tumour extension to the supraglottic and/or subglottic and/or impaired vocal cord mobility

T3 – tumour limited to the larynx with vocal cord fixation and/or invades paraglottic space and/or minor thyroid cartilage invasion (e.g. inner cortex)

T4a – tumour invasion through the thyroid cartilage and/or invades tissues beyond the larynx (e.g. trachea , soft tissues of neck including deep extrinsic muscle of the tongue , strap muscles , thyroid or oesophagus.

T4b- tumour invades pre-vertebral space , encases carotid artery or invades mediastinal structures.

In the sub-glottis , the T stages are as follows :

T1 – tumour limited to the sub-glottis

T2 – Tumour extension into a vocal cord(s) with normal or impaired mobility

T3 – Tumour limited to the larynx with vocal cord fixation

T4a – Tumour invasion through cricoid and thyroid cartilage and/or extension into other tissues beyond larynx (e.g. trachea or soft tissues of the neck , including deep extrinsic muscle of the tongue , strap muscles , thyroid and oesophagus)

T4b – Tumour invades prevertebral space , encases carotid artery or invades mediastinal structures

Regional lymph node, N stage:

NX – Regional lymphnodes cannot be assessed

N0- No regional lymphnodal metastases

N1-Metastases in single ipsilateral lymphnode, 3 cm or less in greatest dimension

N2- Metastases in a single ipsilateral lymphnode more than 3 cm but not more than 6 cm in greatest dimension , or metastases in multiple ipsilateral lymphnodes with none more than 6 cm in greatest dimension , o metastases in bilateral or contralateral lymphnodes none more than 6 cm in greatest dimension.

N2a- Metastases in a single ipsilateral lymphnode more than 3 cm but not more than 6 cm in greatest dimension

N2b –Metastases in multiple ipsilateral lymphnodes , none more than 6 cm in greatest dimension

N2c – Metastases in bilateral or contralateral lymphnodes , none more than 6 cm in greatest dimension

N3 – Metastases in a lymphnode more than 6 cm in greatest dimension

Distant metastases , M Stage :

MX- indicates that distant metastases cannot be assessed

M0 –No distant metastases

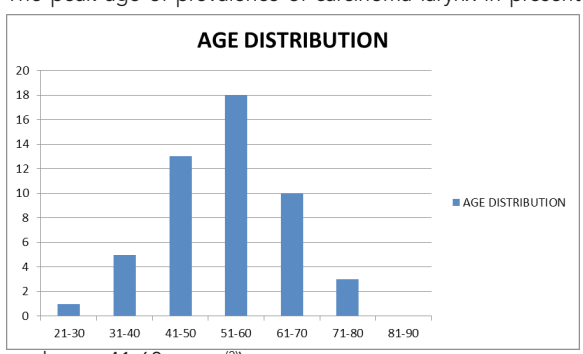
M1 – Distant metastases

OBSERVATION AND DISCUSSION:

TABLE 1: AGE DISTRIBUTION

Sr. no	Age group(yrs)	No. of cases	% of cases
1	20-30	1	2%
2	31-40	5	10%
3	41-50	13	26%
4	51-60	18	36%
5	61-70	10	20%
6	71-80	3	6%
7	81-90	0	0%

The peak age of prevalence of carcinoma larynx in present



study was 41-60 years.[2]\s

TABLE 2: SEX DISTRIBUTION

Sr. no	Sex	No. of cases	% of cases
1	Male	39	78%
2	Female	11	22%

Evidently carcinoma larynx was more common in males than in females.(M:F – approximately 8:2)[2]

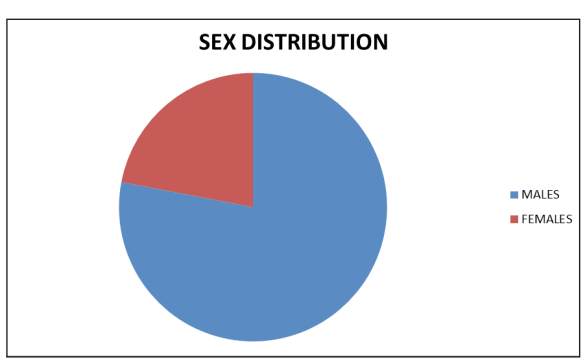


TABLE 3: ALCOHOL OR TOBACCO INCIDENCE

Sr. no	No. of cases	% of cases
1	39	78%

There is high incidence of carcinoma larynx in tobacco/alcohol consumers irrespective of gender.[3],[4]

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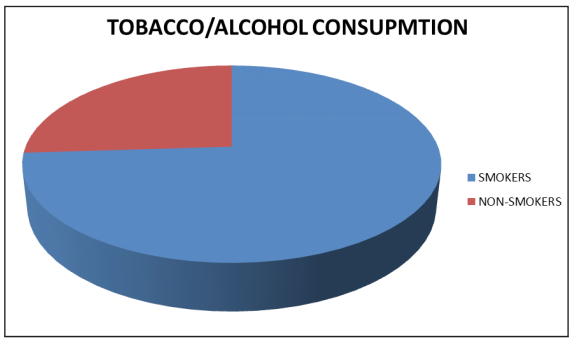

TABLE 4: LARYNGEAL INVOLVEMENT

Sr. no	Laryngeal involvement	No. of cases	% of cases
1	Supraglottis	30	60%
2	Glottis	17	34%
3	Subglottis	3	6%

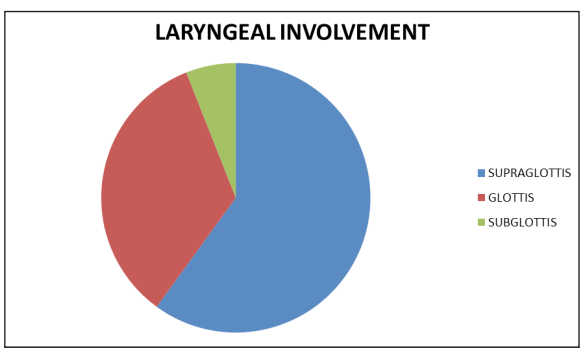

TABLE 5:

Sr. no		Laryngoscopy and biopsy	CT scan detection
1	Supraglottis	30	28
2	Glottis	17	10
3	Subglottis	3	3
	Total	50	41

TABLE 6: INCIDENCE OF DIFFERENT CT STAGES:

Sr. no	CT staging	Supraglottis	Glottis	Subglottis
1	TisN0M0	0	0	0
2	T1N0M0	0	2	0
3	T2N0M0	0	3	0
4	T3N0M0	1	2	0
5	T1N1M0	1	0	0
6	T2N1M0	1	0	0
7	T3N1M0	4	1	1
8	T4N0M0	1	2	0
9	T4N1M0	3	1	1
10	T1N2M0	0	0	0
11	T2N2M0	1	0	0
12	T3N2M0	7	0	0
13	T4N2M0	5	1	1
14	T1-4N3M0	4	0	0
15	T1-4N1-3M1	0	0	0

28 of 30 supraglottic cancer patients presented in the later stages of T (T3 and T4) because they were asymptomatic or caused only mild symptoms and 13 out of 20 patients with glottic and subglottic carcinomas presented in early T stages (T1 and T2).As compared to supraglottic and subglottic carcinomas only 3 out of 17 patients with glottic malignancy had nodal spread which may be due to absence of lymphatics in glottis and early presentation.[5]

TABLE 7: CT STAGING V/S PATHOLOGICAL STAGING:

Sr.no		Total no of patients operated	Identical T stage	Different T stage	Accuracy
1	Supraglottis	22	17	5	75.5%
2	Glottis	5	4	1	80%
3	Subglottis	3	2	1	67%
	Total	30	23	7	74.2%

TABLE 8: N STAGE:

Sr.no		Total no of patients operated	Identical N staging	Different N staging	Accuracy
1	Supraglottic	22	20	2	90.1%
2	Glottis	5	4	1	80%
3	Subglottic	3	2	1	67%
	Total	30	26	4	86.6%

Out of 30 patients 26 patients had same lymphnode station metastases as diagnosed on CT.Thus accuracy of CT scan for N stage was 86.6%.[6],[7]

TABLE 9: CT DETECTION V/S PATHOLOGICAL CORRELATION OF CARTILAGE INVOLVEMENT:

Cartilage involvement	CT scan	No. of patients	Pathology	Accuracy
Extra-laryngeal tumour	9	6	4	66.6 %
Sclerosis	22	15	9	60 %
Erosion or lysis	8	7	4	57.2 %
Extra-laryngeal tumour and erosion or lysis	7	6	4	66.7 %
Extra-laryngeal tumour,sclerosis and erosion or lysis	7	6	6	85.7%

In our study we found that combination of extra-laryngeal tumour , sclerosis and erosion or lysis combined as diagnostic CT criteria for neoplastic cartilage invasion had high sensitivity than a single criterion alone.[12]

DISCUSSION:

In our study incidence of laryngeal carcinoma was more in male than female(M:F-8:2) with peak age of 41-60 years , correlated with the study by Cattaruzza MS et al and Stainslaw Bieri et al(M:F-8:1).

Presence of addiction like alcohol or tobacco was seen in 78% of cases in our study. D Stefani et al also found increased incidence (79%) of laryngeal carcinoma in patients with alcohol and tobacco addiction, being major risk factors for laryngeal cancer to be considered.

Overall sensitivity of CT in staging of carcinoma larynx was 74.2% , being more accurate in diagnosing medium sized lesions (T2/T3) of supraglottic region , well correlated with Wolfensberger et al(76.9%)

In our study sensitivity of CT scan in detection of lymphnodal metastases was 86.6 %. According to Reinhardt et al accuracy of CT in detection of lymphnodal metastases was 84.9 % which is well correlated with our study. Thus CT scan is an important modality for evaluation of lymphnodal metastases.

In our study overall sensitivity of CT in detection of laryngeal cartilage invasion was 85.7 % ,which is considered to be advanced stage disease. A study by becker et al which showed 91% sensitivity of CT scan in detection of laryngeal invasion. Though not very frequently it affects the stage of the disease, CT scan can very well detect cartilage invasion.

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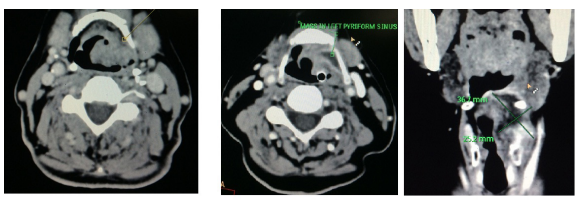
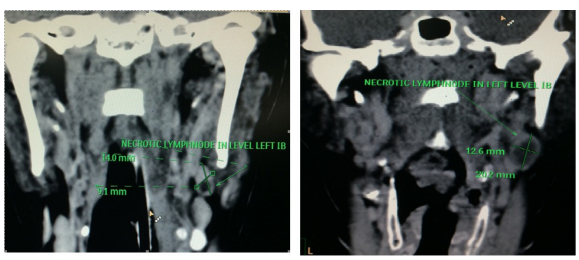
SUMMARY AND CONCLUSION:

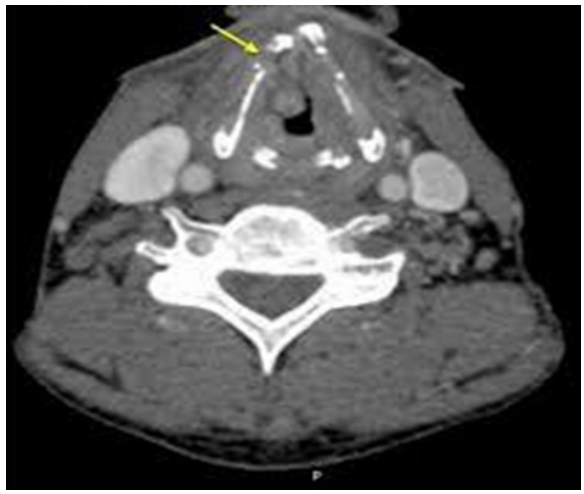
Carcinoma larynx being the most common pathology of larynx is most commonly presented between 40-60 years of age with male predominance and with high incidence of tobacco /alcohol consumption with supraglottis being the most common site and squamous cell carcinoma being the most common histological subtype. Cross sectional imaging like CT is important and most widely used modality to delineate the extent of primary ,nodal spread and to evaluate deeper structures in endoscopically proven neoplasms with easy availability and affordability.



Left pyriform sinus malignancy



NECROTIC CERVICAL LYMPHADENOPATHY



LARYNGEAL CARTILAGE INVASION

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