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Original Research Article

The value of clinical staging of thyroid cancer using ultrasonography and CT scan and its correlation with intraoperative and histopathological findings

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ABSTRACT

Background: Thyroid cancer has incidence of 4 patients per 100,000 populations per year and majority are present between 25-65 years age. Over the years, various imaging have been utilised to detect thyroid cancer but its TNM-staging remains pathological only made on the resected specimen. The aims and objectives of the study was to differentiate thyroid cancer from others lesions, clinically stage them on ultrasonography and CT scan and correlate with histological findings.
Methods: This prospective study was done from March 2012 to April 2015. A total of forty patients of FNAC proven or highly suspicious of thyroid cancer underwent ultrasonography (USG) and CT scan TNM staging before planned surgery. The histopathogical findings of resected specimen were correlated with clinical TNM staging of thyroid cancer. The significance of difference between USG and CT scan was calculated using Chi-square test. The difference in the sensitivity as well in specificity was statistically highly significant ($p<0.001$) and significant ($p<0.005$), respectively.
Results: The largest number of thyroid cancer patient was between 31-40 years with male: female ratio of 1: 4 and 60% presented as asymptomatic lump in the neck. Out of two imaging, the CT scan had more sensitivity and specificity in thyroid cancer staging compared to ultrasonography which had 87.5% sensitivity and 95.8% specificity, respectively.
Conclusions: Overall, the CT scan has more sensitivity and specificity in the assessment of thyroid lesions, thus it may be recommended as imaging method of choice in the clinical staging of thyroid cancer either alone in combination of ultrasonography.

Keywords: Thyroid, Cancer, FNAC, Staging, US- TNM, CT- TNM, Path- TNM, Thyroidectomy

INTRODUCTION

The incidence of thyroid cancer in all races is 4 cases per 100,000 population per year and the majority of patients are between 25-65 years age group.[1] However, in India, thyroid cancer is about 1% of all malignancy in male and 1.7% in female.[2] The prevalence of occult thyroid cancer in various autopsy series has been reported between 3-30%.[3] The follicular carcinoma has greater propensity for haematogenous spread than papillary cancer of thyroid with the incidence between 21-33%.[4,5] The distant metastases from these thyroid cancer have more favourable prognosis in patients age less than 45 years than patients with age ≤45 year and it classified as stage-II disease.[6] Over the years, various imaging methods (e.g. USG, CT scan, MRI) have been used in the imaging of thyroid lesions but controversy remain as how to accurately clinically stage thyroid cancer. Therefore,

many patients may require redo-surgery in the form completion-thyroidectomy after primary resection which predisposes patients to increased morbidity and psychological trauma. Although, the TNM-staging as recommended by AJCC-1998 is most complete but it requires histopathogical analysis after primary resection of thyroid cancer. Thus, the present TNM staging of thyroid cancer is more of the pathological TNM-staging (p-TNM) in the thyroid cancer.[1]

The first use of ultrasonography in thyroid disorder was initiated by Fujimoto et al, who suggested the possibility of detecting intra-thyroidal neoplasm using ultrasonography which lead to its expanded role in the detection of lymph nodes metastases from thyroid cancer.[7-10] Now, with advancement in technique, the high resolution real-time USG can detect occult nodule measuring 2-6 mm in size. The thyroid cancer lesions are seen as solid hypoechoic (63%) or isoechoic lesions with irregular, ill-defined border, heterogeneous internal echo-pattern, central hypervascularity and micro-calcifications.[11-13] Later, the computed tomography axial scan (CAT/CT-Scan) evolved into another potent tool for further evaluation of thyroid cancer patients when thyroid gland was first visualized by Bernard et al on computed tomography of cervical spine.[14,15] The thyroid appears dense without use of contrast due to its high iodine content but thyroid cancer store less iodine, thus appears more hypodense lesion.[16,17]

Aims and objectives

Our study was carried with following aims and objectives:

- To evaluate the efficacy and value of ultrasonography and CT scan in management of thyroid cancer patients.
- To correlate the findings of thyroid cancer on various imaging and correlated with operative as well as histopathogical findings of resected thyroid cancer.

METHODS

This prospective study was carried out in Department of Surgery between years 2012- 2015. Forty patients (n=40) of either fine-needle aspiration cytology (FNAC) proven or highly suspicious for thyroid cancer lesions presenting to in the out patients department of Government Medical College and Hospital, Chandigarh underwent ultra-sonography (USG) as well CT scan of neck along with routine and ancillary investigations. All patients had their clinical TNM-staging using USG (us-TNM) and CT scan (CT-TNM) as per criteria laid in the AJCC-1988 pathological staging of thyroid cancer. In all patients, finding on ultrasonography and CT-scan were correlated with operative and histopathological findings of respected thyroid cancer specimen (p-TNM). The significance of difference between the USG and CT scan finding of thyroid cancer was calculated using Chi-square Test. The difference in the sensitivity between USG and CT scan was statistically highly significant ($p<0.001$) whereas difference in the specificity which also significant ($p<0.005$).

Techniques of imagings

Ultrasonography of thyroid cancer: In all patients of thyroid cancer, the ultrasonography of neck was done using PHILLIPS-SDR-1550XP USG machine with standard Jelly as a coupling media. The ultrasonography images were obtained done in supine position with a sponge or pillow placed under the neck of patients to hyperextend neck and patient's head was slightly turned away opposite to side of examination (which move mandible out of field and gives better access for transducer). USG scanning was done in both planes i.e. the transverse and vertical plane, adopting a systematic and methodical approach for thorough evaluation of the neck. A transducer of 7.5 MHz was glided over the neck perpendicular to skin and each USG scanning took average time between 20-30 minutes. All images obtained on USG were analysed for the size of thyroid cancer lesion, its location, number, capsular invasion, calcifications, lymph nodes and involvement of adjacent structures, especially carotid vessels, straps muscles and parathyroid glands.

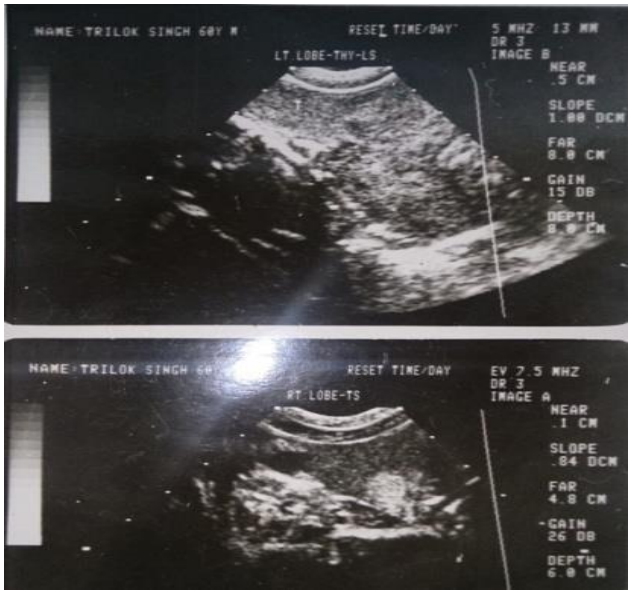

Figure 1: USG showing right thyroid lobe lesion with lymph nodes abutting to internal jugular vein and carotid artery.

The ultrasound scanning was started from the lower pole of thyroid lobes and continued up into middle and upper thyroid pole. The carotid artery and jugular vein were taken as lateral landmark and trachea as medial reference point. These vessels are posterior to strap muscles and anterior to longus colli muscles. The oesphophagus was assessed for its fixity to thyroid malignancy by observing swallowing movements on USG. The longitudinal

scanning was done from medial to lateral directions through upper, middle and lower pole of each thyroid lobes. After this, the thyroid isthmus was scanned both direction but longitudinal scans were found to be more useful. Following this, the lymph nodes and soft tissue structures of neck were assessed for their involvement. The normal thyroid gland appears as smooth, homogenous in texture with medium level of echoes on ultrasonography. The transverse scanning identified carotid artery and internal jugular vein lateral to thyroid lobes, the vulsalva manoeuvre was used for jugular vein distension. The thyroid poles were seen as conical projections moving in cephalic-caudal direction during swallowing movements. The attempt was also made to visualize parathyroid glands, which may appear as radiolucent, if pathological (e.g. in MEN-II).

Figure 2: USG showing left thyroid lobe tumour encasing neck blood vessels.

CT-scan of thyroid cancer

In all patients of thyroid cancer, the CT scan of neck was done on various commercially available CT machines. Both, the plain and contrast enhanced images were taken after injecting 40-60 ml of water soluble radioiodine contrast i.e. Urograffin (76%). The hypersensitivity to contrast was tested by giving a small dose of contrast in each case and waiting for 5-10 minutes before injecting complete dose of contrast to patients and subjecting them to CT scan imaging. The patients were made supine on couch of CT scan machine, positioned in hyperextension to eliminate motion and streak artefact.[10]

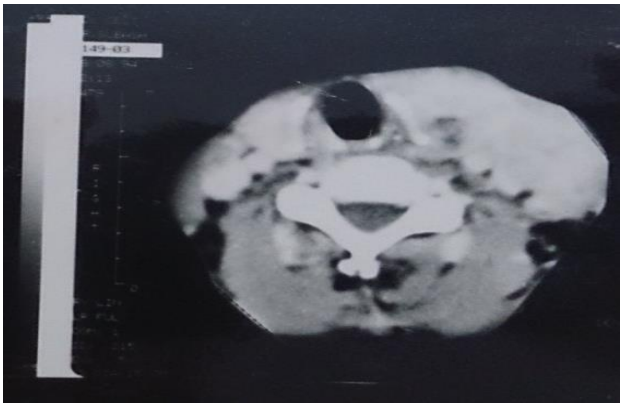

Figure 3: CT scans of thyroid showing large.

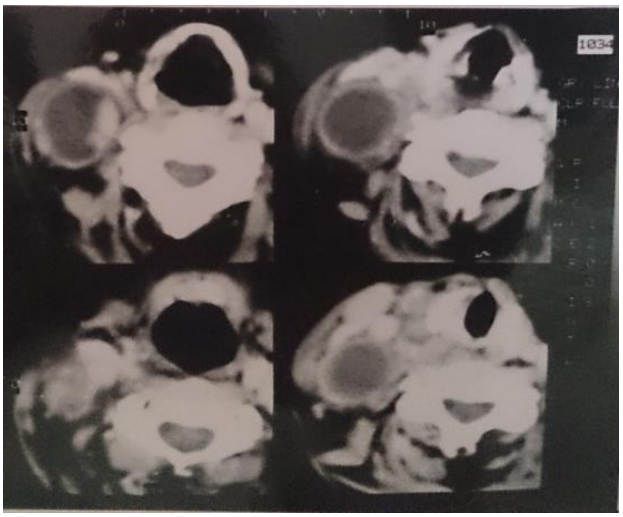

Figure 4: CT of thyroid showing central mass with necrotic lymph nodes necrosis in thyroid cancer.

The CT imaging was done up to lower limit of thyroid cancer with extension into mediastenum, whenever indicated. The thyroid image extended into mediastenum was evaluated by experienced radiologist of our institution. All images were also assessed for substernal extension of thyroid cancer, involvement of lymph nodes, neck vessels, parathyroid glands, infiltration of carotid sheath, strap muscle, trachea and oesophagus.

Surgical management

Out of all forty patients, 32 patients underwent thyroid cancer surgery and in remaining either surgery was not indicated or technical unfeasible. The cancer surgery in the form of hemithyroidectomy was minimum surgical procedure for all suspicious or FNAC (fine needle aspiration cytology) or undetermined cytology e.g. in follicular neoplasm. The near-total or completion thyroidectomy was the standard surgical procedure in patients with confirmed diagnosis and if lymph node were involved then a modified lymph node dissection of neck was also done.

Observation

All thyroid cancer presented clinically as solitary or multi-nodular goitre except in two patients, one presented with metastases to sternum, confirmed on 99 mTc DTPA (dimercapto succinic acid) scan and another with metastases to skull. Out all forty patients, 34 were clinically and biochemically euthyroid. The eight patients were male and thirty two female with male to female ratio of 1:4. The majority presented with sign and symptoms suggestive of malignancy for average of one year duration. The ultrasonography and CT-scan findings were compared to operative and histopathological of the

resected tumour specimens. Out of thirty two, 25 patients had papillary thyroid cancer and 07 follicular cancers.

Table 1: Compare of US-TNM and CT-TNM to path-TNM (pathological) staging of thyroid cancer.

	N (%)	N (%)	N (%)
A) Tumours			
Definitions of tumours	**US-T**	**CT-T**	**path-T**
T1-Tumor <1 cm size	2 (6.25)	12 (37.5)	0
T2-Tumor ≥1 cm size but <4 cm size	10 (31.25)	20 (62.50)	10 (31.25)
T3-Tumor >4 cm size	20 (62.50)	0 (0.0)	20 (62.50)
T4-Tumor beyond thyroid capsule	0 (0.0)	0 (0.0)	2 (6.25)
Total	32 (0.0)	32 (0.0)	32 (0.0)
B) Lymph nodes			
Definitions of lymph nodes	**US-N**	**CT-N**	**path-N**
No – No lymph node involvement	22 (68.75)	18 (56.25)	14 (43.75)
N1a – Ipsilateral lymph nodes involvement	10 (31.25)	14 (43.75)	18 (56.25)
N1b – Bilateral or mediasternal lymph nodes involvement	0 (0.0)	0 (0.0)	0 (0.0)
Total	32 (100)	32 (0.0)	32 (0.0)

Table 2: Compare path-TNM with US-TNM and CT-TNM staging of thyroid cancers.

Stage	path-TNM	US-TNM	CT-TNM
	N **(%)**	N **(%)**	N **(%)**
Stage – I	0	12 (37.5)	12 (37.5)
Stage – II	10 (31.25)	10 (31.25)	6 (18.75)
Stage – III	20 (62.50)	6 (18.75)	8 (25.00)
Stage – IV	2 (6.25)	4 (12.50)	6 (18.75)
Total	32 (0.0)	32 (0.0)	32 (0.0)

Table 3: The sensitivity and specificity of USG and CT scan in thyroid cancer patients.

TNM-Stage	USG scan		CT scan	
	Sensitivity (%)	**Specificity (%)**	**Sensitivity (%)**	**Specificity (%)**
Stage – I	100	100	100	100
Stage – II	100	84.46	100	100
Stage – III	75	100	100	100
Stage – IV	66	100	100	100

Distant metastases: Thyroid cancers with metastases to liver, lung, skull, bone or anaplastic carcinoma were labled as stage-IV. The distant metastases were detected on radiology of skull and chest except one case which required CT scan of chest.

Table 4: The average sensitivity and specificity of USG and CT scan in thyroid cancers.

Used imaging	Sensitivity (a/a+b) (%)	Specificity (c/c +d) (%)
USG-scan	87.5	95.8
CT-scan	100	100

RESULTS

The largest number of thyroid cancer patient were between 31-40 years with male: female ratio of 1: 4 and majority (60%) presented as asymptomatic lump in the neck. Out of two imaging methods, the CT scan had more sensitivity and specificity in thyroid cancer staging compared to ultrasonography which had (87.5%) and (95.8%), respectively. Overall, the CT scan is better methods of imaging in thyroid cancer and its staging compared to ultrasonography.

DISCUSSION

The preoperative treatment planning of thyroid cancer remains a dilemma for majority of surgeons, despite availability of advanced imaging methods e.g. USG, CT scan, MRI and nuclear scan.[18] This study was done to define the exact values of ultrasonography and CT scan in the staging thyroid cancer before subjecting patients to unavoidable multiple surgeries. The basis for choosing CT scan over MRI or nuclear scan was that it is better in detecting calcification, less expensive, easily available and has potential to differentiate benign from malignant thyroid tumour. Although, MRI provide superior image

and better tissue contrast without risk of any radiation but it cannot not differentiate hyperplasia from metastatic to thyroid.[19] Moreover, the MRI of thyroid tumours is costly, time-consuming and not available in most institution of India.

The ultrasonography detected malignant thyroid lesion measuring ≥10 mm in size and 63% lesion appeared as hypoechoic and 26 isoechoic lesions. Although, the ultrasonography of neck successfully detected lymph node involvement in 24 (60%) thyroid cancer patients but it failed in another 6 (15%). The infiltration into oesophagus was seen in two cases and assessment could not be carried out in another two for lack of compliance by the patients compliance and experienced ultrasonologist. The infiltration into straps muscle and carotid sheath was also seen in two patients. The average sensitivity and specificity of ultrasound in detecting malignant thyroid cancer was 87.5% and 95.8%, respectively. On clinical staging using USG and CT scan, the 12 (37.5%) vs. 12 (37.5%) were stages-I, 10 (31.25%) vs. 6 (18.75%) stage-II, 6 (18.75%) vs. 8 (25.00%) stage-III and 4 (12.50%) vs. 6 (18.75%), respectively. However, after histopathogical examination of resected thyroid cancer specimen, none in stage-I, 10 (31.25%) stage-II, 20 (62.50%) stage-III and 2 (6.25%) had Stage-IV thyroid cancer. CT scan was done in 38 patients and abandoned in two due to large thyroid cancer and respiratory distress in lying down position. Majority of thyroid cancers appeared hypodense area in normal, less hyperdense thyroid gland. CT scan accurately detected tumour measuring ≥1 cm size and lymph node involvement in all except in 4 cases. Although, CT scan has its limitations in detecting involved lymph nodes ≤1 cm size but it better visualized lymph nodes compared to USG. The infiltration of straps muscles and carotid sheaths was seen in 10 patients but confirmed histopathologically in 4 patients only and in remaining, it was adherent to straps muscles.

The results in our study were comparable to study done by Jainulabdeen et al in 23 patients, who also observed that USG and CECT had sensitivity and specificity of 71.4% and 33.3% and 52.4% and 66.7%, respectively in determining malignant nodule.[20] The lymph node staging on histopathological findings was also in agreement with USG in 65-2% and CECT in 65.2% patients, thus they concluded that CECT should be used as an adjuvant to USG in the clinical staging of disease and to determine extent of disease.[20] Our study was also comparable to study done by Na et al, who compared USG and CT in the preoperative staging of papillary thyroid carcinoma in 299 patients and for primary thyroid cancer >1 cm size, the USG and CT had sensitivity and specificity of 66.1% vs.71.2% and 74.5% vs. 88.1%, respectively but when both were used, the sensitivity and specificity increased to became 77.3% and 59.6%, respectively.[22] For the assessment of lateral compartmental lymph nodes, the USG and CT had sensitivity and specificity of 94.6% vs. 78.4% and 50% vs. 100%, respectively but when both were used, the sensitivity and specificity increased to became 97.3% and 50.0%, respectively. Thus, they concluded that CT had greater sensitivity than USG alone and USG with CT had greater sensitivity than CT alone in evaluation of lateral lymph node metastases.[22] The variables sensitivity and specificity in different study can be explained by the fact that ultrasound examination of neck require some experience by ultrasonologist. The experience gained by the ultrasonologist and refinement in techniques of USG might be able improve the sensitivity and specificity of ultrasonography in the clinical TNM staging of thyroid cancer.[21]

In contrast, the high accuracy of CT scan in thyroid cancer may be attributed to fact that it better delineate calcifications, tissue plane and lymph nodes.[22] Therefore, CT scan more accurately stage thyroid cancers with potential to predict its prognosis. However, our study revealed that CT scan also require improvement in its technique to detect small size metastatic lymph nodes. It may be possible that spiral or helical CT scan may be able overcome this problem by detecting smaller size thyroid cancer lesions and metastases to lymph nodes through better delineating characters of lesion and its surrounding structures. Till date, the exact impact of magnetic resonance imaging in thyroid cancer staging is yet to be seen by the majority of surgeons. Further, the role of FFDG PET and PET/CT in preoperative imaging of thyroid cancer is relatively new.[8,18]

CONCLUSION

The ultrasonography and CT scan of neck and it correlation with operative and histopathogical finding of resected thyroid cancer specimens revealed that both the method are very good in clinically stage thyroid cancer with high sensitivity and specificity but CT scan is far better for the purpose, attributed to fact that it better delineate calcifications, tissue plane and lymph nodes.. Thus, it is concluded that CT scan is better in staging of thyroid cancers.

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