Original Article

Is a Surgeon-performed Ultrasound Good Enough in Diagnosing Thyroid Malignancy?

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Abstract

Background: The widespread availability of ultrasonography has facilitated the evaluation of thyroid nodules, to differentiate between malignant and benign nodules and between metastatic and reactive lymph nodes. From the radiologists' suite, ultrasound has moved into the surgeon's office. **Aim:** The aim of the present study was to evaluate the relevance of surgeon-performed ultrasound (SPUS) in the diagnosis of malignancy of the thyroid. **Methods**: SPUS for 389 consecutive patients attending the outpatient department of endocrine surgery in a tertiary care institute in Chennai. The SPUS data of 350 patients who underwent total thyroidectomy were compared with the report of radiologist-performed ultrasonogram, fine-needle aspiration cytology, and histopathology examination. **Results:** SPUS ranked the maximum with a Spearman's correlation of 0.886 ($P < 0.0001$). The sensitivity and specificity of positive-predictive value and negative-predictive value of SPUS were 98.53%, 95.72%, 96.81%, and 98%, respectively. **Conclusion:** SPUS is a very useful clinical adjunct in diagnosing malignancy of the thyroid and saves the patient time and resource in visiting another consultant. A surgeon who is more familiar with the anatomy and pathophysiology of thyroid disorders triages the nodule better.

Keywords: Malignancy of thyroid, surgeon-performed ultrasound, ultrasonogram of thyroid

Introduction

Most of the patients attending the outpatient ward of endocrine surgery department present with nodular goiter. Of this, 90% of the cases are benign. It is essential for the endocrine surgeon to identify the remaining 10% of the malignant cases at an early stage[1] (the incidence of malignancy is fast increasing), so that they can be managed appropriately with reduced morbidity.

Clinical symptoms of hoarseness of voice, pressure effects, and signs of fixity appear much later. Fine-needle aspiration cytology (FNAC) is a useful clinical adjunct distinguishing the benign goiters from the malignant ones, misses malignancy in about a third of the lesion[2] and the negative-predictive value is never a 100%. Ultrasonogram is an extension of the clinician's arms and the shadows cast help in distinguishing the benign nodules from the malignant ones.[3] Moreover, it is quick, painless, inexpensive, reproducible, and safe to all patients without any radiation hazard. It can also be combined with FNAC to improve the diagnostic accuracy.[4] However, the interpretation of images is operator dependent. Apart from this, it is also useful in assessing the regional lymph nodes which is important for determining the extent of lymph node dissection and evaluating the biologic behavior including prognosis.

When a surgeon, who is more acquainted with the anatomy of the neck,[5] performs an ultrasound, he/she obtains more real-time information from the images, which helps in making accurate management decisions and saves the patients effort and time in approaching another consultant.

The objective of this study is to evaluate the effectiveness of surgeon-performed ultrasound (SPUS) in identifying malignancy of the thyroid for its early and effective management.

Aim of the study

To evaluate the relevance of SPUS in the diagnosis of malignancy of the thyroid with an objective of identifying

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patients with malignant nodule who would benefit from early surgery while avoiding unnecessary investigation and surgery for patients with a benign nodule.

Methods

This prospective cohort study was performed in the department of endocrine surgery in a tertiary care institute in Chennai over a period of 2 years between March 2010 and 2012. After ethical committee clearance, all patients with goiter attending the outpatient department of endocrine surgery who gave informed consent for the study were included.

These patients were evaluated clinically and baseline thyroid function tests were obtained. Ultrasound of the neck was performed by radiology residents on a rotation using Siemens Acuson Antares Premium model with a 7.5–15 MHz linear array transducer probe in the department of radiology. In euthyroid patients, FNAC of the thyroid was performed by pathology residents in the department of cytology with a 23 mm gauge needle using nonaspiration technique. Slides were fixed in isopropyl alcohol and H and E staining was done. Slides were reported based on the Bethesda system of cytopathology. Inconclusive and unsatisfactory smears were repeated under ultrasound guidance.

Ultrasound of the neck was performed by a single surgical resident at the time of admission, blinded for the sonographic and FNAC report, using a DUS 3 Digital Ultrasonic Diagnostic Imaging System with a multifrequency 5–15 MHz linear array transducer probe. The following parameters were noted during the time of sonographic examination: echotexture of the lobes, presence of nodularity, echogenicity and location of the nodules, presence of halo and calcifications – micro, macro, and eggshell, and the regularity of margins. Doppler was not performed and so Doppler findings were not included for analysis.

Based on the sonographic appearance, the diagnoses were made as shown in Table 1.

Antonelli's criteria was used for diagnosing nodal metastasis. Hypoechoic or heteroechoic nodes with loss of fatty hilum, round or irregular shaped nodes with or without cystic degeneration and internal calcification were considered to be malignant. Those cohorts who did not undergo total thyroidectomy were excluded from the study. The postsurgical specimen was grossed, fixed in formalin. Paraffin-embedded tissue was sliced to 2-cell thickness and stained with hematoxylin and eosin. Reporting was done as per the department protocol.

Statistical analysis

Data were analyzed using a 17.0 SPSS software. The results of the SPUS were compared with that of the radiologist-performed ultrasound (RPUS), FNAC, and histopathology examination (HPE) by cross tabulation. Ranking of the variables was done using the Mann–Whitney nonparametric test and correlated by Spearman's correlation test. Logistic regression multivariate analysis was done to compare nodule characteristics with malignancy.

Table 1: Diagnosis of thyroid lesions based on sonographic appearance

Ultrasonographic features	Diagnosis
Round or oval anechoic lesion	Cyst
Regularly-shaped nodule with cystic change or spongiform pattern	Colloid nodule
Regular nodule with or without septations or coarse calcifications	Adenomatous goiter
Solid, hypoechoic, isoechoic, or hyperechoic nodule with or without calcifications with a regular halo	Adenoma
Hypoechoic/heteroechoic gland with or without nodules with or without calcifications	Thyroiditis
Hypoechoic gland with small nodules with echogenic bands across both the lobes of the gland	
Hypoechoic/heteroechoic nodule with regular/irregular margins with fine/coarse calcifications	Papillary carcinoma

Results

Ultrasonogram was performed for 389 patients. The data of 350 patients who underwent total thyroidectomy were taken for analysis. Of the 350 patients, 93 patients were diagnosed to have malignancy by histopathology. In this, there were 79 (84.9%) females and 14 (15.1%) males. The age distribution of the malignant population was 11–75 years and the mean age of presentation was 43.45 years. Five of them had vocal cord palsy preoperatively. The clinical profile of 93 patients was as follows – multinodular goiter: 53, solitary nodule thyroid: 32, toxic multinodular goiter (MNG): 3, and MNG with lymphadenopathy: 5.

The pathological profile of the patients included the following – papillary carcinoma: 86, medullary carcinoma: 3, metastatic medullary carcinoma: 2, and metastatic papillary carcinoma: 2.

The 86 cases of papillary carcinoma [Figure 1] included conventional type: 36, follicular variant: 28, micropapillary carcinoma: 19, anaplastic variant: 1, clear cell variant: 1, and tall-cell variant: 1.

SPUS, RPUS, and FNAC were ranked with HPE.

SPUS had the maximum rank with $P < 0.0001$. The Spearman's correlation of all the three parameters is given in Table 2.

There were 11 false-positive cases (11.2%) of SPUS of which 8 were reported as papillary hyperplasia, 2 as oncocytic adenomatoid hyperplasia, and 1 as adenoma. Five (2%) false-negative cases (3 colloid nodules and 2 thyroiditis) were reported [Table 3]. There were 13 (22%) false-positive cases and 47 (16.2%) false-negative cases in RPUS.

The sensitivity, specificity, positive-predictive value, and negative-predictive value of SPUS are 98.53%, 95.72%, 96.81%, and 98.00%, respectively [Table 4]. The sensitivity

Sonographic picture of papillary carcinoma thyroid

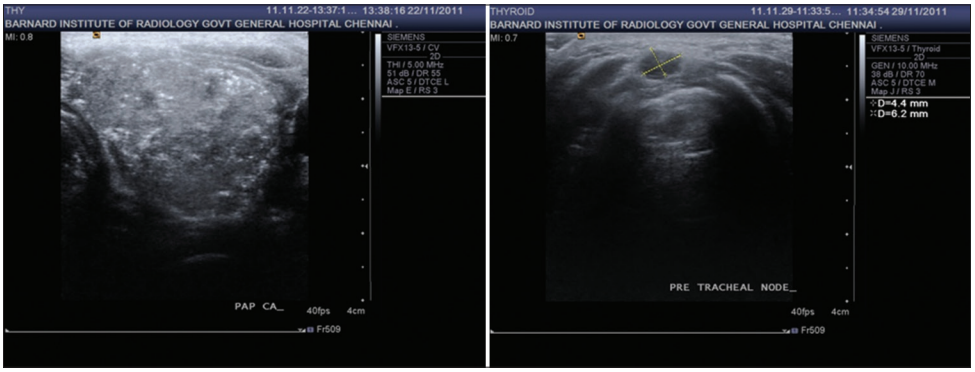

Figure 1: Hypoechoic nodule with calcifications pretracheal lymph node with loss of fatty hilum

Table 2: Correlation of surgeon-performed ultrasound, radiologist-performed ultrasound, fine-needle aspiration cytology against variable histopathology examination

	Spearman's correlation	SE	Approximate TC	Significance
SPUS	0.886	0.028	35.652	0.00001
RPUS	0.524	0.053	11.474	0.00001
FNAC	0.405	0.052	8.258	0.00001

SPUS: Surgeon-performed ultrasound, FNAC: Fine-needle aspiration cytology, SE: Standard error, RPUS: Radiologist-performed ultrasound, TC: Ties correction

Table 3: Comparison of surgeon-performed ultrasound findings with histopathology examination

	Gross HPE		Total (%)
	Benign (%)	Malignant (%)	
Gross SPUS			
Benign			
Count	246	5	251
Percentage within gross SPUS	98.0	2.0	100.0
Malignant			
Count	11	88	99
Percentage within gross SPUS	11.1	88.9	100.0
Total			
Count	257	93	350
Percentage within gross SPUS	73.4	26.6	100.0

SPUS: Surgeon-performed ultrasound, HPE: Histopathology examination

Table 4: Comparison of sensitivity and specificity of surgeon-performed ultrasound, radiologist-performed ultrasound, fine-needle aspiration cytology

	SPUS (%)	RPUS (%)	FNAC (%)
Sensitivity	98.53	86.05	82.18
Specificity	95.72	94.94	95.62
Positive-predictive value	96.81	95.9	96.11
Negative-predictive value	98.00	83.8	81.08

SPUS: Surgeon-performed ultrasound, FNAC: Fine-needle aspiration cytology, RPUS: Radiologist-performed ultrasound

and negative-predictive value of SPUS is higher than RPUS and FNAC, while the specificity and positive-predictive value are high for RPUS and FNAC showing that the surgeon's threshold for diagnosing malignancy is low.

When multivariate analysis of nodule characteristics in SPUS was performed, heteroechogenicity (odds ratio [OR]–3.782 95% confidence interval [CI]–1.012–14.13 $P < 0.048$), irregular margins (OR = 11.756 95% CI–4.939–27.982 $P < 0.000$), and microcalcifications (OR = 32.567, 95% CI–12.094–87.693 $P < 0.000$) had a greater association with differentiated thyroid cancer after adjustment for the other characteristics. This was in contrast to study by Jabiev *et al*.[6] in which hypoechogenicity had a higher correlation.

Discussion

The increase in incidence of thyroid cancer is definitely because of improved diagnosis of even small nodules <5 mm, and this has been made possible because of the availability of high-resolution ultrasound.

SPUS has become an important diagnostic modality for the evaluation of thyroid nodules by many endocrine surgeons. As an extension of the clinical examination of the neck, SPUS provides the unique opportunity to integrate real-time ultrasound images with clinical presentation and the extensive knowledge of surgical neck anatomy that can be correlated later intraoperatively. Moreover, the surgeon sonographer can effectively monitor patients for persistent or recurrent thyroid cancer.

However, the interpretation of findings is operator oriented. A cystic metastatic node or an abnormal lymph node adjacent to the thyroid may be mistaken for a benign thyroid nodule, especially if they are calcified. Ultrasound sonogram (USG) characteristics of thyroiditis include enlargement of the thyroid with reduced echogenicity, heterogeneity, and hypervascularity which may be mistaken for a large nodular infiltrative malignancy, especially when associated with destructive thyroiditis or vice versa. Medullary carcinoma of thyroid especially with coarse calcifications may be mistaken for a colloid nodule.

Although hypoechogenicity is an established parameter in detecting thyroiditis, it has poor specificity in the morbidly

obese with body mass index >40,[7] where it was present in 64.8% of clinically and biochemically euthyroid patients.

When diffuse thyroid abnormalities are present, detection of focal nodules particularly thyroid carcinoma is more difficult.[8] A solid hypoechoic papillary carcinoma could be masked in a heterogeneous thyroid gland containing pseudonodules from lymphocytic infiltrates and fibrosis. Benign follicular adenomas can have a heteroechoic appearance with calcifications and can be mistaken for malignancy. Microcalcifications which are pathognomonic of papillary carcinoma can also be present in follicular adenomas and Hashimoto's thyroiditis and can be misinterpreted as malignancy. Coarse calcifications can be present in long-standing malignancy and in benign degenerative disorders. Eggshell calcifications though predominantly seen in benign lesions can present in malignancy. While imaging the lymph nodes, the fatty hilum may not be conspicuous in benign reactive nodes when small and homogenous nodes without the hilar shadow may be reported as malignant nodes. Similarly, the heteroechogenicity and peripheral shift of the fatty hilum may not be evident in small malignant nodes in the early stage of infiltration and may be interpreted as benign.

Thus, it becomes evident that the wide variations in the sonographic findings between the radiologist and surgeon could be because of overlap of sonographic features. Even among the experienced ultrasonographers, concordance of USG characteristics is never 100%.[9] Hence, similar discrepancies would exist between the interpretations of the surgeon and radiologist.

It also becomes evident that single sonological feature correlates poorly with malignancy and a constellation of features is a better predictor. However, pattern analysis only points to the possibility of malignancy but does not give tissue proof unlike FNAC.

Although FNAC gives a preoperative diagnosis of thyroid cancer, it has a high false-negative rate, especially if the nodule is >4 cm. From the cytopathologic perspective, most thyroid cancers are low grade and have pathologic features that overlap with other benign hyperplastic or neoplastic nodules. Inadequate sampling, geographical misses of the lesion, and dual pathology are the difficulties in diagnostic thyroid cytology. In malignancy, the negative-predictive value of a screening test should be ideally 100%. The inherent zones of gray and overlap in cytology make this impossible.

Thus, the reasons for the wide variations in reporting malignancy can be multifactorial and can be due to patient and regional characteristics, operator and processing techniques, surgical pathology analysis, and diagnostic threshold.

By combining clinical, ultrasonographic, and immunohistochemical markers, it is possible to overcome the pitfalls in diagnosis.

Conclusion

Ultrasound has definitely revolutionized the management of thyroid nodules. When a surgeon performs it, he/she gains more real-time information and this information can be used to alter the management plan. Surgeon triages a nodule better. Even microcarcinomas with false-negative FNAC can be identified by SPUS.

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Conflicts of interest

There are no conflicts of interest.

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