Correlation between histopathology of solitary thyroid nodule and thyrotropin thyroglobulin ratio

Original Article

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ABSTRACT

Background: Differentiated thyroid cancers are becoming more common, along with thyroid disorders. Palpable thyroid nodules are seen in the patient population at a rate of 5% in female patients and 1% in male patients. Aging is associated with an increased incidence of thyroid nodules. Owing to advances in technology and the accessibility of medical facilities, the incidence of incident thyroid nodules has increased to as high as 19–68%.

Aim: Detection of diagnostic accuracy of thyrotropin to thyroglobulin ratio in comparison with postoperative pathology to differentiate between benign and malignant solitary thyroid nodule.

Patients and Methods: This prospective study was conducted on 50 patients presented with solitary thyroid nodule to the general surgery and endocrine surgery outpatient clinics at Mansoura University Hospitals. They were chosen according to inclusion and exclusion criteria. Thyrotropin and thyroglobulin levels were estimated for all patients, ratio between them was calculated, and then this ratio was compared with final postoperative pathology to detect the diagnostic accuracy of this ratio in differentiation between benign and malignant nodule.

Results: The final pathology showed that 41 (82%) of the studied patients had benign nodules and nine (18%) had malignant nodules. Using of thyrotropin thyroglobulin ratio cut of value 25.94, we find that 40 patients proved to be benign from total 41 benign patients and eight patients proved to be malignant from total nine malignant patients. Area under the curve for thyrotropin thyroglobulin ratio is excellent (area under curve0.97) with the best detected cut off point is 25.94 yielding sensitivity 88.9% and specificity 97.6% with total accuracy 96%.

Conclusion: From the study it is shown that thyrotropin thyroglobulin ratio is of great significance in differentiation between benign and malignant solitary thyroid nodule with best cut off point is 25.94.

Key Words: Fine needle aspiration biopsy, solitary thyroid nodule, thyrotropin thyroglobulin ratio.

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INTRODUCTION

The prevalence of thyroid nodules in the general population ranges from 4% by palpation to 67% by ultrasonography. Based on autopsy examinations, nodules were found in 50% of individuals; most of these are impalpable. The prevalence of thyroid nodules rises with age, with women experiencing a four-fold higher incidence than men do[1].

There is still debate about the best course of action for managing nodules because some medical professionals advise removing them entirely due to the risk of cancer[2].

However, surgeon and endocrinologists advise performing fine needle aspiration cytology (FNAC) as a first evaluation step in order to prevent needless surgery. Since thyroid nodules are so frequent, it is not possible to operate on every patient who has a thyroid mass because the total incidence of thyroid nodules is far higher than the incidence of malignancy[3].

Determining the benignity or malignancy of thyroid nodules in patients is the primary focus. The problem of gray-zone nodules that require additional diagnostic testing persists, even though fine needle aspiration biopsy is the most often utilized for assessment of the nodules preoperatively. More preoperative markers have been recommended as having prognostic and predictive value to help prevent an inappropriate surgical decision. Since thyroglobulin is a readily available and affordable test, there has been increased attention in the last 10 years over its potential efficacy in identifying preoperative malignancy in thyroid nodules[4].

The thyroid-stimulating hormone (TSH) receptor is expressed on the membranes of differentiated thyroid cancer cells, and in response to TSH stimulation, these

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cancer cells express more thyroid-specific proteins and proliferate at a faster pace. TSH is necessary for the active process of thyroglobulin synthesis and secretion. There should be a correlation between blood TSH level and thyroglobulin[5].

Research has examined correlations between blood TSH or thyroglobulin values and cancer risk in thyroid nodule patients[6].

PATIENTS AND METHODS:

This study included 50 patients presented with solitary thyroid nodule to the General Surgery and to the Endocrine Surgery Unit Outpatient Clinics at Mansoura university hospitals.

The study was conducted during the period between September 1, 2021 and the end of November 1, 2023.

All patients perform thyrotropin and thyroglobulin levels preoperatively and the ratio was calculated (Figs 6 and 12) and compared with post-operative pathology report (Fig. 5).

All patients signed an informed consent to their participation in this study, with prior approval of the local ethical committee to the study.

All patients underwent FNAC and ultrasonography.

Then, all the patients were planned for surgery (Figs 2 and 9) after getting anesthetic fitness, total thyroidectomy was done in 21 patients, hemi-thyroidectomy was done in 25 patients and transaxillary endoscopic hemithyroidectomy was done in four patients.

After surgery, the removed thyroid specimen (Figs 3 and 10) was submitted for histopathological examination (Figs 4 and 11).

Comparative study was done between preoperative thyrotropin thyroglobulin ratio with final histopathology to detect diagnostic accuracy in differentiation between malignant and benign nodule.

Type of the study: cross-section study with analytic component.

Inclusion criteria: male or female, patient fit for surgery, patient has solitary thyroid nodule, and patients with euthyroid state.

Exclusion criteria: pregnancy, liver, or kidney diseases and patient unfit for surgery.

All patients underwent; full medical history, general and local examination, radiological investigations, full laboratory investigations, FNAC.

Complete history taking were obtained from all cases including.

Personal history: name, sex, age, residence, occupation, special habits, and marital status.

Complaint and present history: the size, site, course (gradual or fast progressive), and presenting symptoms (visible, incidental or palpable mass, dysphagia, pain, weight loss or voice changes as hoarseness) are all taken into consideration while analyzing the thyroid lesion.

Past medical and surgical history: history of prior neck surgery or radiation exposure.

Present history: history of comorbidities as hypertension, diabetes mellitus, cardiac, hepatic and renal diseases.

Drug history: history of having thyroid replacement treatment or anti-thyroid medications and its duration, drug allergy history.

Family history: family history of similar conditions.

General examination: general look of the patient, body built, decubitus, consciousness level, vital signs (blood pressure, pulse, temperature). Examination of the chest, head, abdomen and extremities was done. Weight, length, and BMI was done for the patients.

Local examination: checking the neck for any clinically palpable thyroid enlargement (Figs 1 and 7). Assessment of the nodule include; size, site, shape, contour, mobility, consistency, relation to surroundings, retrosternal extension, skin over, audible bruit, and pulsation. Then the cervical lymph nodes were examined.

Full laboratory investigations: free serum T3 and T4 levels, TSH blood level, thyroglobulin level, liver function tests, kidney function test (serum creatinine), complete blood count, INR, blood grouping, blood glucose, and HbA1c for diabetic patients.

Radiological studies

Thyroid ultrasound: to establish the nodule's solid or cystic nature and to determine its TIRADS classification. Following the Bethesda categorization standards, ultrasound-guided FNAC was performed on all patients presenting to the endocrine surgery unit outpatient clinic with evidence of thyroid nodule.

Neck and upper chest radiograph to look for any pulmonary metastatic nodules, calcifications, retrosternal extension, or tracheal displacement.

Computed tomography scan was carried out for patients who had a large MNG or a goiter that extended retrosternally.

Indirect laryngoscopy to assess the vocal cords' range of motion.

Histopathological study

(1) FNAC guided by ultrasound was performed on each patient who had a thyroid nodule and came to the endocrine surgery unit's outpatient clinic in accordance with the Bethesda classification guidelines.

(2) Intraoperative frozen section was done in 36 patients as frozen section was not available in some patients, patients with unavailable frozen section or who has suspicious nodule underwent total thyroidectomy and who proved to be benign with frozen section underwent hemi-thyroidectomy.

(3) Final pathology. After surgery, the thyroid specimen was sent to the Department of Pathology, Mansoura Faculty of Medicine for the paraffin section and thyrotropin-thyroglobulin ratio was compared with the final pathology report.

Case Examples 1

Figs. 1-6.

Fig. 1: Female patient 46 years old presented with solitary thyroid nodule on RT side

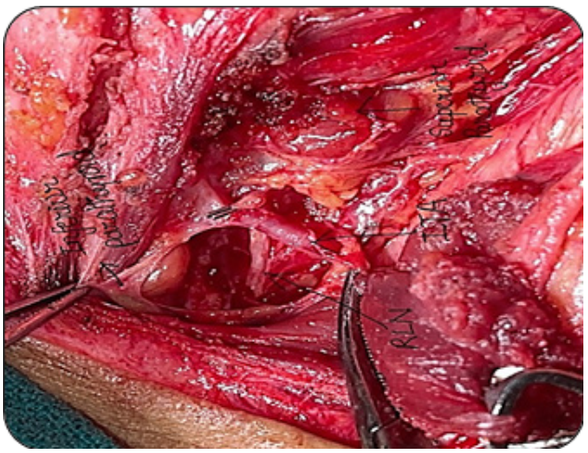


Fig. 2: Intra-operative thyroid bed, superior and inferior parathyroid gland, ITA and RLN

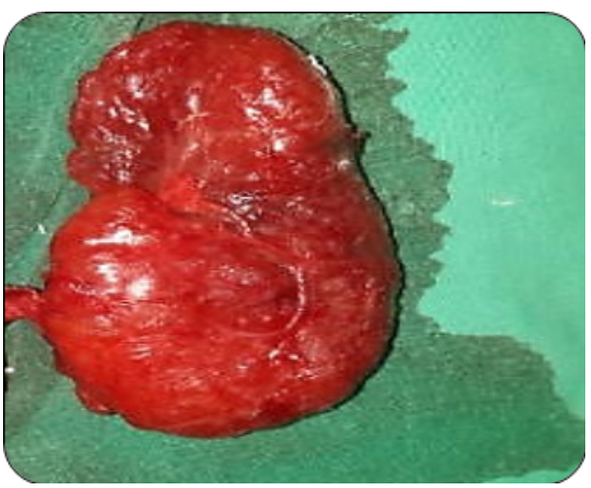


Fig. 3: Specimen is RT lobe with mixed cystic solid nodule 24*15 mm (BY U/S (TIRADS 4))

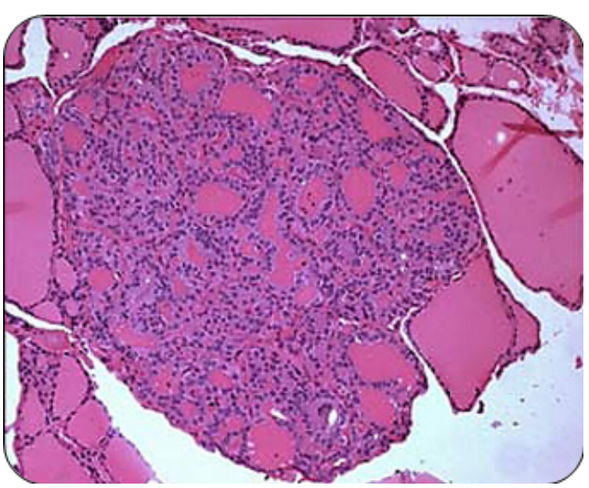


Fig. 4: Post-operative pathology showing hyperplastic nodule with papillary micro-carcinoma

Microscopic Examination	- Examination of prepared slides revealed well circumscribed nodule with thin capsule. It is formed of predominant microfollicles. They are lined by bland follicular epithelial cells. - A focus of papillary microcarcinoma measuring 0.7cm in greatest dimension is detected. It is formed of branching papillary structures that are lined by follicular cells that show nuclear enlargement, clearing, overlapping & occasional nuclear pseudo-inclusions with foci of calcination. These papillary structures are surrounded by fibrosis.
Diagnosis	- Hyperplastic nodule with papillary microcarcinoma.

Fig. 5: Pathology report from IBN-Sina system.

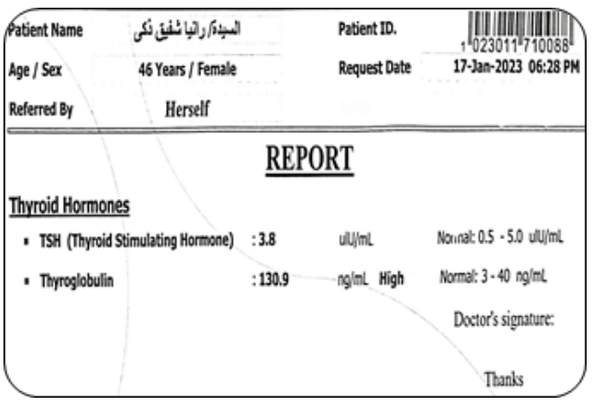


Fig. 6: Preoperative level of TSH 3.8 - Thyroglobulin 130.9 - Ratio 29.03

Case Examples 2

Figs. 7-12.

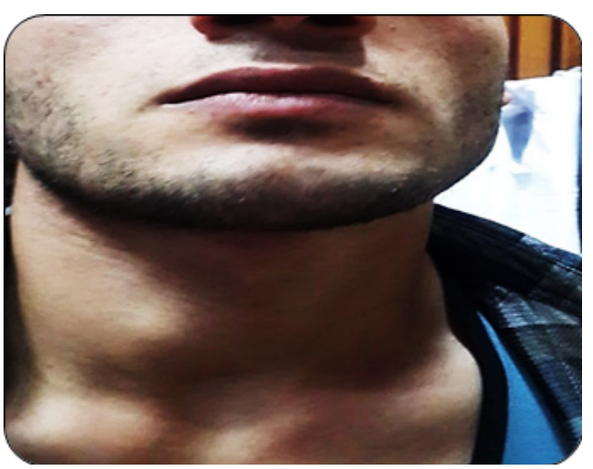


Fig. 7: Male patient 36 years old presented by solitary thyroid nodule on RT side

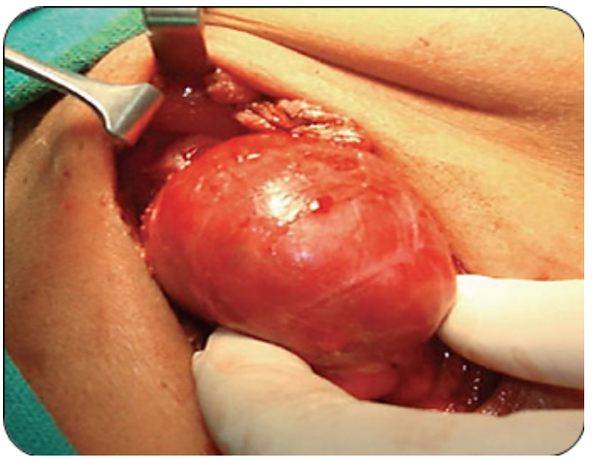


Fig. 8: Showing intraoperative for RT hemi thyroidectomy

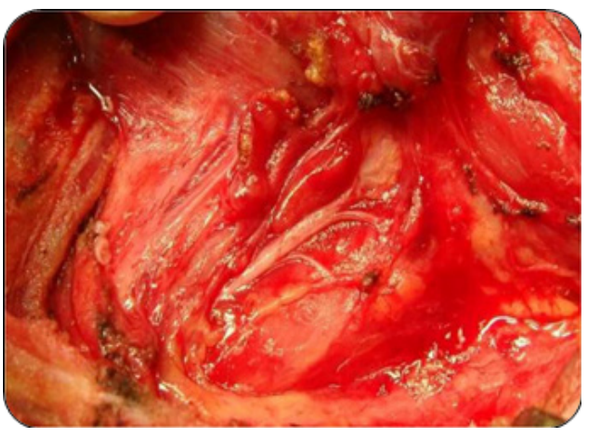


Fig. 9: Showing thyroid bed and recurrent laryngeal nerve.

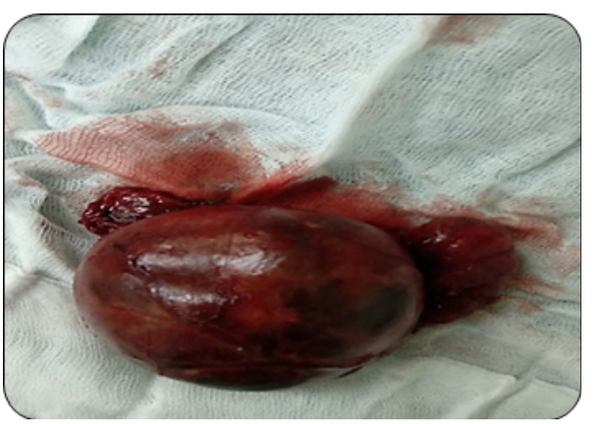


Fig. 10: Specimen is RT lobe with thyroid nodule 3*3 cm (U/S isoechoic nodule with cystic degeneration TIRADS2)

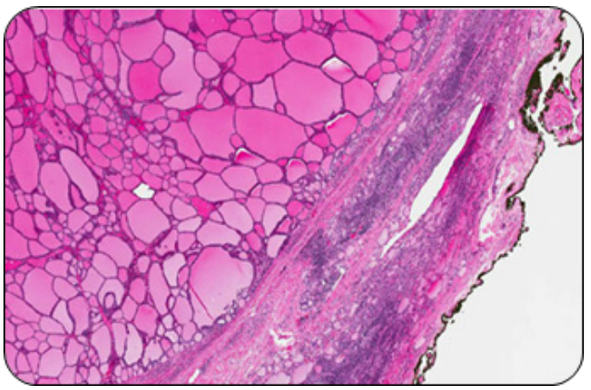
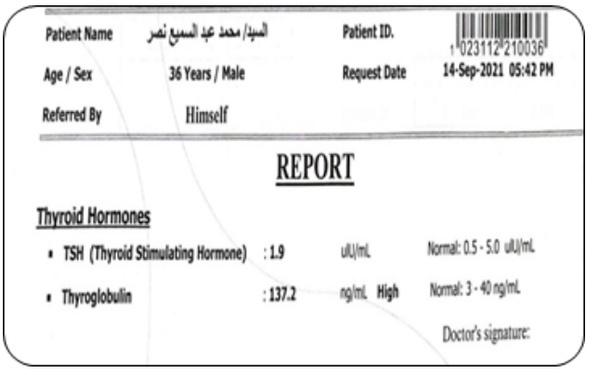


Fig. 11: Pathology of case no 2 is follicular adenoma



Patient Name	السيد/ محمد عبد السميع نصر	Patient ID.	1'023112'210036'
Age / Sex	36 Years / Male	Request Date	14-Sep-2021 05:42 PM
Referred By	Himself		

REPORT

Thyroid Hormones

• TSH (Thyroid Stimulating Hormone)	: 1.9	uU/mL		Normal: 0.5 - 5.0 uU/mL
• Thyroglobulin	: 137.2	ng/mL	High	Normal: 3 - 40 ng/mL

Doctor's signature:

Fig. 12: Pre-operative levels of TSH and Thyroglobulin, (Ratio was calculated 13.85) for case 2

RESULTS:

Our study was conducted on 50 patients (41 of them were females and nine were males).

They were provisional diagnosed with solitary thyroid nodule presented to the General Surgery and Endocrine Surgery Outpatient Clinics at Mansoura University hospitals.

They were chosen according to the inclusion and exclusion criteria.

Demographic characteristics according to the pathology (Table 1) showed with no significant difference that the mean age in patients with malignant nodules was 40.78 higher than the age in the patients with benign nodules (35.54).

The overall incidence of thyroid nodule in female is more common than the male, in benign lesion females were 34 (82.9%) and males were seven (17.1%) and in malignant nodules female were seven (77.8%) and males were two (22.2%) with no significant difference as regard the age.

Our study showed with significant difference between benign and malignant nodule that; FNAC results as regards Bethesda system (Table 2, Fig. 13) in patients with benign thyroid nodules. Three (7.3%) of them were Bethesda I, 14 (34.1%) of them were Bethesda II, 22 (53.7%) of them were Bethesda III and two (4.9%) of them were Bethesda IV. While the results in patients with malignant nodules one (11.1%) of them were Bethesda III, five (55.6%) of them were Bethesda IV, and three (33.3%) of them were Bethesda V.

TIRADs score (Table 3, Fig. 14) showed significant difference between benign and malignant nodule, so in the benign nodule three (7.3%) of them was TIRADs I, 16 (39%) of them were TIRADs II, 21 (51.2%) of them were TIRADs III, and one (2.4%) were TIRADs IV. TIRADs score in malignant nodules showed that one (11.1%) were TIRADs III, four (44.4%) were TIRADs IV, and four (44.4%) were TIRADs V.

Frozen section was done in 36 patient, which represent 72% of all cases (Table 4). The result showed with significant difference between benign and malignant nodules that the patients with benign nodules 12 (29.3%) of them frozen section was not available at time of operation. Twenty (48.8%) were colloid nodular goiter, four (9.8%) were goiterous nodule with lymphocytic thyroiditis, five (12.2%) were follicular neoplasm for paraffin section to detect vascular and capsular invasion. However, the frozen section results in patients with malignant nodules showed that; two (22.2%) of them not available at time of the operation. One (11.1%) of them were colloid nodular goiter, one (11.1%) of them were follicular neoplasm for paraffin section to detect vascular and capsular invasion and five (55.6%) of them were suspected papillary thyroid carcinoma with sensitivity, specificity, PPV, NPV, and accuracy as following 71.4, 100, 100, 93.5, and 94.4% considering intermediate group classified in benign group.

The type of the operation in both thyroid lesion showed (Table 4) with no significant difference that the patients with benign nodule 14 (34.1%) of them underwent total thyroidectomy, 23 (56.1%) of them underwent hemi-thyroidectomy and four (9.8%) of them underwent endoscopic trans-axillary hemi-thyroidectomy. Nevertheless, the patient with malignant nodules seven (77.8%) of them underwent total thyroidectomy and the remaining two (22.2%) of them underwent hemi-thyroidectomy so they underwent completion thyroidectomy after hemi-thyroidectomy.

The final pathology reports (Table 5) showed that 41 (82%) of the nodules were benign, and nine (18%) were malignant nodules.

The nodules, 25 (50%) of them were colloid goiter, five (10%) of them were focal thyroiditis, eight (16%) of

them were follicular adenoma and three (6%) of them were hemorrhagic cyst which were benign nodules.

While five (10%) of all nodules were papillary thyroid carcinoma, one (2%) of them were poorly differentiated carcinoma, two (4%) of them were follicular thyroid carcinoma and one (2%) of them were Hurthle cell carcinoma which were malignant nodules.

The laboratory finding (Table 6) showed that the mean of TSH was 1.94 µIU/ml in benign nodules and 2.93 µIU/ml in malignant nodules with significant difference. The findings also showed with significant difference in thyroglobulin level between benign and malignant nodules that the mean of thyroglobulin in benign nodules was 136.36 and 78.1 ng/ml in malignant nodules. Thyrotropin thyroglobulin ratio was calculated, the results showed with significant difference that the mean of the ratio in benign nodules was 15.95 and in malignant nodules was 50.78.

Using of thyrotropin thyroglobulin ratio cut of value 25.94 (Table 7), we find that 40 patients proved to be benign from total 41 benign patients and eight patients proved to be malignant from total nine malignant patients.

Area under the curve (AUC) for thyrotropin thyroglobulin ratio is excellent (AUC=0.97) with the best detected cut off point is 25.94 yielding sensitivity 88.9% and specificity 97.6% with total accuracy 96% but at cutoff point 20.8 the sensitivity and NPV increased to 100% on the expense of specificity, PPV, and accuracy. Therefore, the best cutoff point of TSH to thyroglobulin ratio was 25.94 (Table 8, Fig. 15).

AUC for TSH is good (AUC=0.848) with the best detected cut off point is 2.16 µIU/ml yielding sensitivity 88.9% and specificity 65.9% with total accuracy 70%.

AUC for thyroglobulin is failed (AUC=0.203) with the best detected cut off point is 80.824 ng/ml yielding sensitivity 66.7% and specificity 17.1% with total accuracy 26% (Table 9, Fig. 16).

Table 1: Demographic characteristics according to the pathology of the studied patient

	Benign (*N*=41)	Malignant (*N*=9)	Test of significance
Age in years			*t*=1.339
Mean±SD	35.54±9.99	40.78±13.4	*P*=0.187
Sex			
Male	7 (17.1)	2 (22.2)	χ^2=0.133
Female	34 (82.9)	7 (77.8)	*P*=0.716

t, Student *t* test; χ^2, χ^2 test.

Table 2: Fine needle aspiration cytology results according to Bethesda system in both benign and malignant nodules

FNAC	Benign (*N*=41)	Malignant (*N*=9)	Test of significance
Bethesda I	3 (7.3)	0	
Bethesda II	14 (34.1)	0	χ^2=33.841
Bethesda III	22 (53.7)	1 (11.1)	*P*<0.001*
Bethesda IV	2 (4.9)	5 (55.6)	
Bethesda V	0	3 (33.3)	

χ^2, χ^2 test.
*Statistically significant.

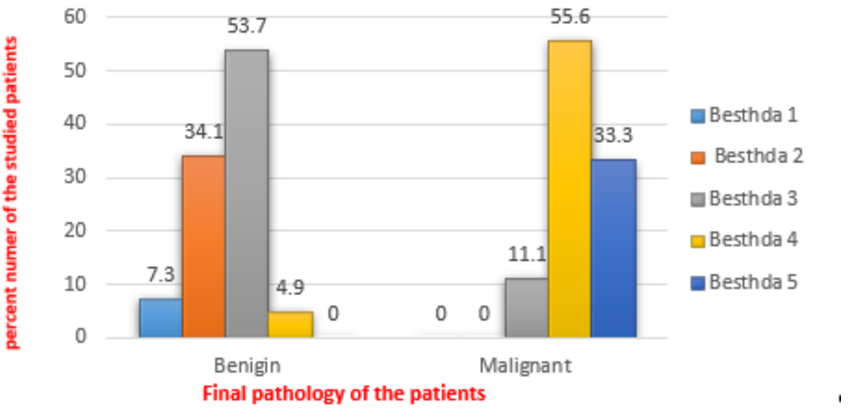


Fig. 13: FNAC results according to Bethesda system in benign and malignant nodules.

Table 3: TIRADs score of the nodule in both benign and malignant nodules

TIRADs score	Benign (*N*=41)	Malignant (*N*=9)	Test of significance
TIRADs I	3 (7.3)	0	
TIRADs II	16 (39)	0	χ^2=38.113
TIRADs III	21 (51.2)	1 (11.1)	*P*<0.001*
TIRADs IV	1 (2.4)	4 (44.4)	
TIRADs V	0	4 (44.4)	

χ^2, χ^2 test.
*Statistically significant.

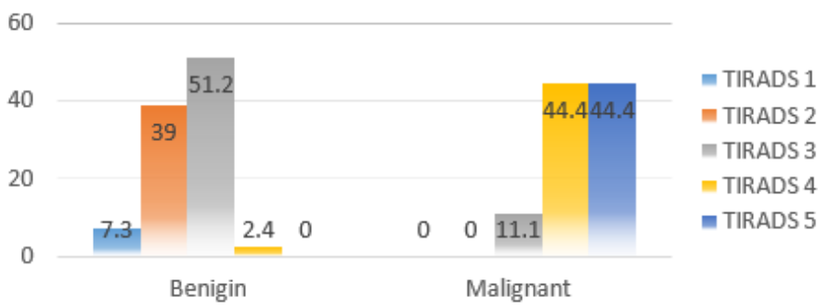


Fig. 14: TIRADS score at the benign and malignant nodules.

Table 4: Frozen section results and operation type at both benign and malignant nodules

	Benign (*N*=41)	Malignant (*N*=9)	Test of significance
Frozen			
Not done	12 (29.3)	2 (22.2)	χ^2=26.287
Benign	24 (58.5)	1 (11.1)	*P*<0.001*
Colloid nodular goiter	20 (48.8)	1 (11.1)	
Goitrous nodule with lymphocytic thyroiditis	4 (9.8)	0	
Intermediate	5 (12.2)	1 (11.1)	
Follicular neoplasm for paraffin section	5 (12.2)	1 (11.1)	
Malignant	0	5 (55.6)	
Suspected papillary thyroid carcinoma	0	5 (55.6)	
Operation			
Total thyroidectomy	14 (34.1)	7 (77.8)	χ^2=5.917
Hemi-thyroidectomy	23 (56.1)	2 (22.2)	*P*=0.052
Trans-axillary Endoscopic hemi-thyroidectomy	4 (9.8)	0	

χ^2, χ^2 test.
*Statistically significant.

Table 5: Final pathology of the studied patients

Final pathology	*n* (%)
Benign lesions	*N*=41 (82%)
Colloid goiter	25 (50)
Hashimoto's thyroiditis	5 (10)
Follicular adenoma	8 (16)
Hemorrhagic cyst	3 (6)
Malignant lesions	*N*=9 (18%)
Papillary thyroid carcinoma	5 (10)
poorly differentiated carcinoma	1 (2)
Follicular thyroid carcinoma	2 (4)
Hurthle cell carcinoma	1 (2)

Table 6: Laboratory findings at both benign and malignant nodules

	Benign (*N*=41)	Malignant (*N*=9)	Test of significance
TSH (µIU/ml)	1.94±0.73	2.93±0.67	*t*=3.724 *P*=0.001*
Thyroglobulin (ng/ml)	136.36±74.5	78.1±39.8	*t*=2.265 *P*=0.02*
TSH/thyroglobulin ratio	15.95±5.5	50.78±32.53	*Z*=4.381 *P*<0.001*

t, Student *t* test; Z, Mann–Whitney U test.
*Statistically significant.

Table 7: Cut off value of thyrotropin thyroglobulin ratio more than 25.94 in both benign and malignant nodules

TSH/thyroglobulin cut of value 25.94	Benign	Malignant	Test of significance
Benign	40	1	*t*=11.916
Malignant	1	8	*P*=0.001*
Total	41	9	

t, Student *t* test.
*Statistically significant.

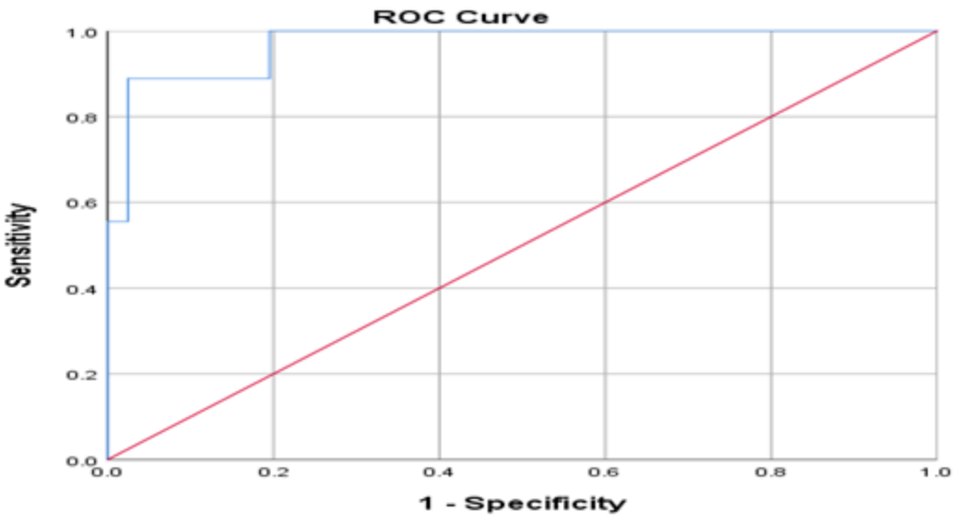


Fig. 15: ROC curve for thyrotropin thyrogobulin ratio in differentiang between benign and malignant nodules. ROC, receiver operating characteristic.

Table 8: Validity of thyrotropin thyroglobulin ratio in differention between benign and malignant nodules

	AUC (95% CI)	*P* value	Cut off point	Sensitivity %	Specificity %	PPV %	NPV %	Accuracy %
TSH/thyroglobulin	0.97 (0.922–1)	*P*<0.001*	25.94	88.9	97.6	88.9	97.6	96.0
			20.8	100	80.5	52.9	100	84

AUC, area under curve.

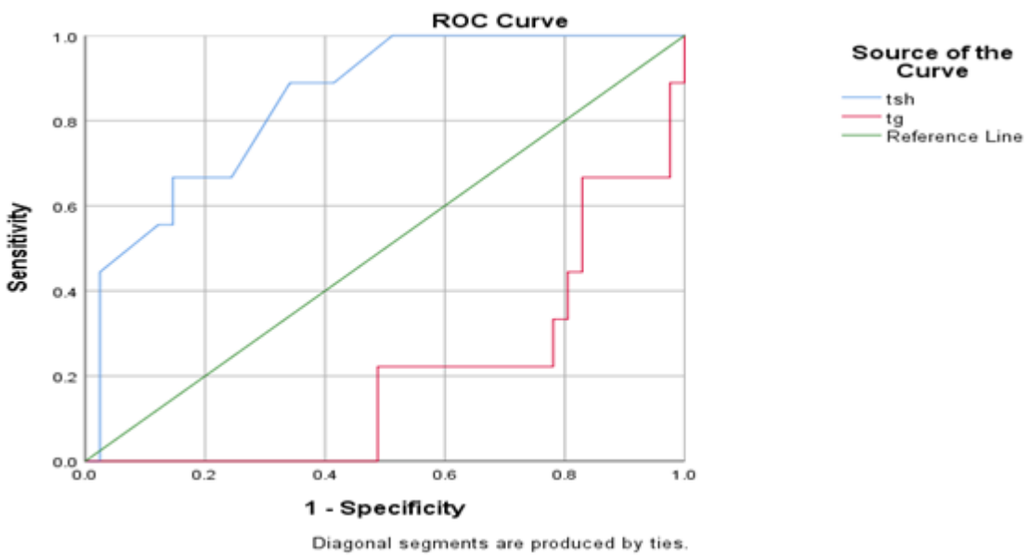


Fig. 16: ROC curve for TSH and thyroglobulin in differentiation between benign and malignant nodules.

Table 9: Validity of TSH and thyroglobulin in differention between benign and malignant nodules

	AUC (95% CI)	*P* value	Cut off point	Sensitivity %	Specificity %	PPV %	NPV %	Accuracy %
TSH (μIU/ml)	0.848 (0.725–0.971)	0.001	2.16	88.9	65.9	36.36	96.43	70
Thyroglobulin (ng/ml)	0.203 (0.059-0.348)	0.006	80.824	66.7	17.1	15	70	26

AUC, area under curve.

DISCUSSION

Regarding thyroid profile, the current study showed the malignant group have highly significant high TSH/thyroglobulin ratio (*P<0.001*), significantly lower thyroglobulin (*P=0.02*) compared to benign group and significant higher TSH in malignant nodules than the benign nodules (*P<0.001*). However, the malignant group have nonsignificant high FT3 and FT4 compared to benign group (*P>0.05*). In concordance with the current study Abotaha *et al*.[7] showed that the malignant patients exhibited significantly higher TSH, TSH/thyroglobulin, and a lower thyroglobulin compared to the benign patients (*P<0.05* for each). Furthermore, they concluded that preoperative TSH/thyroglobulin could be used as a predictive marker for differentiating between benign and malignant thyroid nodules. In addition, in harmony with the current study Aydogdu *et al*.[8] showed that there was significant difference between benign and malignant groups as regard TSH/thyroglobulin ratio (*P≤0.001*). Also, in agreement with this study Tam *et al*.[9] revealed that TSH/thyroglobulin was significantly higher in the malignant nodules compared to benign nodules (*P<0.05*). In the regression analysis, TSH/thyroglobulin demonstrated higher diagnostic performance compared to TSH and thyroglobulin (*P<0.001*). As well, Wang *et al*.[5] determined that a greater preoperative serum thyrotropin to thyroglobulin ratio is associated with a higher risk of thyroid cancer, and that the thyrotropin to thyroglobulin ratio has a stronger link with malignancy than serum TSH. Furthermore, Karvounis *et al*.[10] revealed that higher TSH/thyroglobulin ratio and lower thyroglobulin were identified as risk factors for thyroid nodules malignancy. However, Yazici *et al*.[4] in univariate analysis showed that the TSH to thyroglobulin ratio was a predictor for thyroid malignancy (OR 0.001; 95% CI, 0.01–0.125; *P=0.007*).

To test the diagnostic accuracy of TSH to thyroglobulin ratio to differentiate between benign and malignant nodule, ROC curve analysis was performed and revealed that TSH to thyroglobulin ratio can significantly discriminate benign from malignant nodule with AUC was 0.97, at cutoff point 25.94 the sensitivity, specificity, PPV, NPV and accuracy were 88.9, 97.6, 88.9, 97.6, and 96.0%, respectively.

In concordance with the current study Sharma *et al*.[11] showed that at cutoff point of 25.02 for TSH to thyroglobulin ratio showed AUC of 1 with a sensitivity of 100%, and a specificity of 100% to differentiate benign from malignant nodules. In addition, Tam *et al*.[9] showed that TSH to thyroglobulin ratio could predict thyroid malignancy with 61.9% sensitivity and 74.1% specificity. Similarly, Aydogdu *et al*.[8] showed that TSH to thyroglobulin ratio could predict thyroid malignancy with AUC of 0.680, sensitivity of 64.2% and specificity of 62.7%.

The diagnostic ability was also tested for TSH and thyroglobulin using ROC curve analysis, and the results showed poorer diagnostic accuracy of both markers to differentiate benign from malignant nodules than ratio. Wang *et al*.[5] observed that the AUC was 0.659 for TSH. The sensitivity, specificity, positive predictive value, positive likelihood ratio, and negative likelihood ratio for TSH were 74.0%, 53.2%, 70.8%, 1.58, and 0.49, respectively, with a cutoff point value of 1.525 lIU/ml. TSH had an odds ratio of 3.23 for cancer.

The current study revealed that there was no statistically significant difference between benign and malignant groups as regards the operation. Addasi *et al*.[12] showed that hemithyroidectomy is a good treatment option for many low-risk thyroid cancers and is associated with less extensive surgery, lower rates of surgical complications, and a lower risk of postoperative asthenia in appropriately selected patients. When recommending hemithyroidectomy, it is important to ensure that adequate preoperative evaluation has been completed and that not only the short-term surgical plan is discussed, but also the long-term issues regarding thyroid hormone therapy, surveillance, need for additional surgery and follow-up, ability to predict recurrence, and QOL.

Limitations

The current study was limited by small sample size, being a single center study and relatively short follow up period.

CONCLUSION

From this study, it is shown that thyrotropin thyroglobulin ratio is of great significance in differentiation between benign and malignant solitary thyroid nodule. This ratio is of great importance as it is noninvasive and cost effective procedure with high diagnostic index.

This study showed that thyrotropin to thyroglobulin ratio could serve as a practical and applicable index for risk stratification of thyroid nodules. In addition, with combination with other investigations as FNAC, ultrasound and frozen sections this ratio could aid physicians to take important decisions regarding the management of thyroid nodules.

Increased level of either serum thyrotropin only or thyroglobulin appears not to be useful for prediction of malignant thyroid nodules. However, thyrotropin to thyroglobulin ratio was found to be significantly increased in patients with thyroid cancer.

Further studies with larger sample size and longer follow-up are needed to confirm our results and to assess the prognostic ability of thyrotropin to thyroglobulin ratio.

CONFLICT OF INTEREST

There are no conflicts of interest.

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