Correlation of Thyroid Imaging, Reporting and Data System (TIRADS) Score with Fine Needle Aspiration Biopsy and Histopathology in Post Thyroidectomy Patients: A Single Center Experience

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Abstract

Introduction. Thyroid cancer is the most common endocrine related malignancy in the Philippines. Data showed Filipino patients are at higher risk to develop thyroid malignancy with an increasing incidence annually. Currently, the initial screening test utilized to evaluate thyroid nodules is ultrasonography with studies showing promising results in detecting and evaluating thyroid carcinoma employing the use of the Thyroid Imaging, Reporting and Data System (TIRADS). TIRADS is a standardized classification system to evaluate and characterize thyroid nodules. However, there are studies stating that TIRADS is of limited clinical value for risk stratification of indeterminate cytological results.

Objectives. The primary objective of this study is to determine the correlation of the results of TIRADS, Fine Needle Aspiration Cytology (FNAC), and histopathology of thyroid nodules among patients who underwent thyroidectomy at Makati Medical Center from January 2016 to March 2020.

Methods. This is a retrospective, analytical, observational, cross-sectional study wherein medical records of patients who were diagnosed with thyroid nodules goiter who underwent thyroid ultrasound with TIRADS scoring, Fine needle Aspiration Biopsy (FNAB) and ultimately thyroidectomy were reviewed. The primary endpoint included diagnostic performance of TIRADS classification and the possible factors that may contribute to discordance to FNAB and Histopathology.

Results. One hundred twenty-five patients who underwent thyroidectomy were reviewed. These patients underwent thyroidectomy on the basis of their fine needle aspiration biopsy results. With FNAB as a reference standard, TIRADS had good sensitivity of 100% and low specificity of 27.7% in detecting thyroid malignancy. Patients who had FNAB positive or suspicious for malignancy are 1.37 times more likely to yield a positive TIRADS compared to patients who are FNAB negative (LR+), and 94% less likely to yield a negative TIRADS result (LR-). When TIRADS is positive, the positive predictive value was 31.3% and when TIRADS is negative, the negative predictive value (NPV) was nearly 100%. Overall, the accuracy of TIRADS in thyroid malignancy is 45.6% with ROC area at 0.638, indicating fair discriminative power of TIRADS to differentiate between benign vs malignant thyroid nodules. With histopathology as a reference standard, TIRADS had good sensitivity of 96.3% and low specificity of 33.8%. Patients who are histopathology positive are 1.45 times more likely to yield a positive TIRADS compared to patients who are histopathology negative (LR+), and 89% less likely to yield a negative TIRADS result (LR-). When TIRADS is positive, the positive predictive value was 52.5% and when TIRADS is negative, the negative predictive value (NPV) was 92.3%. Overall, the accuracy of TIRADS in thyroid malignancy is 60.8% with ROC area at 0.65, indicating fair discriminative power to differentiate between benign versus malignant thyroid nodules.

Conclusion. TIRADS classification provides high sensitivity value in detecting thyroid malignancies but has fair discriminative power to differentiate between benign versus malignant thyroid nodules. Factors that are associated with discordant classification between TIRADS and FNAB were seen in those who underwent total thyroidectomy with lymph

node dissection, and solid composition. There is insufficient evidence to determine whether any of the patient or nodule characteristics were associated with discordance between TIRADS and histopathology.

Keywords. TIRADS, Thyroid Nodule, FNAB, Bethesda Score, Histopathology

Introduction

For the past decade, the incidence of thyroid cancer has been increasing, and it accounts for 1% of all malignancies, but it is considered to be the most common form of endocrine malignancy. It has increased fourfold in females and threefold in males. The worldwide age-standardized rate is 6.10/100,000 women and 1.90/100,000 men.[1] Recent data indicate an upward trend in incidence and a downward trend in mortality. It can be attributed to increased detection of the disease, improvement and changes in diagnosis, treatment, and risk factor exposure. [2] In the Philippines, thyroid cancer is the most common endocrine related malignancy. [3] Data show that Filipino patients are at higher risk to develop thyroid malignancy which may be attributed to iodine deficiency. According to a study last 2018 by Elham G. et. al., the worldwide cancer registrations in 2018 show 567,223 new cases (3.31%) of thyroid cancer of which 41,071 (0.46%) died due to this malignancy. According to the study, the highest thyroid cancer incidence was in the Asia continent with 340,245 (60%) cases. The highest mortality rate was also found in Asia with 23,847 cases (58.1%).[4] According to a study done last 2012 by Holgado et. al, Papillary Carcinoma accounts for the majority of Malignant lesions (82.9%) followed by Follicular Carcinoma (11.1%) of which the former showed a more aggressive and recurrent behavior.[5]

Fine-needle aspiration cytology or FNAC is utilized as one of the methods to diagnose thyroid nodules due to its higher sensitivity and predictive value for diagnosis than any other single diagnostic method. The Bethesda system classifies thyroid FNAC into six categories for thyroid cytology reporting: (Category I: No-diagnostic or Unsatisfactory, Category II: Benign, Category III: Atypia of Undetermined Significant/Follicular Lesion of Undetermined Significance, Category IV: Follicular neoplasm or Suspicious for a follicular neoplasm, Category V: Suspicious for malignancy, and Category VI: Malignant). Each category is linked to a malignancy risk and has a recommended clinical management.

One of the best imaging modalities to visualize the thyroid is still by ultrasonography due to its easy accessibility, cost-effectivity, and non-invasiveness. Thyroid Imaging Reporting and Data Systems (TIRADS) is a standardized classification system to evaluate thyroid nodules. Several studies done on TIRADS were done since 2009 and showed promising results on detecting and evaluating thyroid carcinoma. [6-8] However a study by Chaigneau, G Russ et. al, showed that TIRADS score is of limited clinical value for risk stratification of indeterminate cytological results.[9] With this study, it aims to determine if TIRADS will be a vital tool in the management of thyroid malignancies.

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Objectives

General Objective

To determine the correlation of the results of TIRADS with FNAC, and with Histopathology of the thyroid among patients who underwent thyroidectomy at Makati Medical Center from 2016 to 2020

Study Procedures

1. To determine the sensitivity, specificity, PPV, NPV of TIRADS in determining malignancy in patients with thyroid nodules, with Bethesda and Histopathology as standard.
2. To determine the different factors that may affect discordance among the TIRADs, Bethesda Classification and histopathology results.

Study Design

This study was a single center retrospective, analytical, observational, cross-sectional study on patients who underwent thyroidectomy for thyroid nodules. Medical records including thyroid ultrasound with TIRADS scoring and fine needle Aspiration Biopsy were reviewed. This study was reviewed and approved by the Institutional Review Board of the Makati Medical Center.

Methods

This study included all patients who underwent thyroidectomy performed between January 2016 to March 2020. Medical records of all the patients were reviewed. After obtaining approval, Thyroid ultrasound results and Histopathology reports were accessed in the Radiology and Pathology Departments.

TIRADS scores were determined using the American College of Radiology System (ACR) classification depending on the different characteristic of the nodule which include the nodule's composition (cystic, spongiform, mixed cystic and solid, or solid or almost completely solid), echogenicity (anechoic, isoechoic or hyperechoic, hypoechoic, and very hypoechoic), shape (wider than tall or taller than wide), and margin (smooth, ill-defined, lobulated/irregular, or with extra-thyroidal extension). All the characteristics were given

corresponding scores which were added and classified to the different categories. TIRADS score were classified

from categories 1 to 5: TIRADS 1 corresponded to a benign nodule, TIRADS 2 to a not suspicious nodule, TIRADS 3 to a mildly suspicious nodule, TIRADS 4 to a moderately suspicious nodule, and TIRADS 5 to a highly suspicious nodule.

Fine Needle Aspiration biopsy results gathered were reported according to the Bethesda System (Bethesda I: No-diagnostic or Unsatisfactory, Bethesda II: Benign, Bethesda III: Atypia of Undetermined Significant/Follicular Lesion of Undetermined Significance, Bethesda IV: Follicular neoplasm or Suspicious for a follicular neoplasm, Bethesda V: Suspicious for malignancy, and Bethesda VI: Malignant).

All the subjects included in the study were assigned an alphanumeric code to maintain anonymity.

Study Subjects

According to a study by Canete, et al, the prevalence of thyroid nodules in the Philippines is 8.9%. Using a 95% confidence interval and 5 % margin of error, a minimum sample size of 125 is needed for this study.

Inclusion Criteria

All patients 19 years old and above who underwent Thyroidectomy with histopathology and who had Thyroid Ultrasound and Fine Needle Aspiration Biopsy results.

Exclusion Criteria

Patients who only had either FNAC/FNAB or Thyroid Ultrasound results prior to thyroidectomy and patients who had history of prior thyroid surgeries and Radioactive Iodine Ablation were excluded from the study.

Statistical Analysis

Descriptive statistics was used to summarize the general and clinical characteristics of the subjects. Frequency and proportion were used for nominal variables, median and range for ordinal variables, and mean and standard deviation for interval/ratio variables.

Independent sample t-test was used to determine the difference in the mean age of patients between those with benign vs malignant histopathology. Fisher's Exact/Chi-square test was used to determine the difference of frequency between those with benign vs malignant histopathology.

Diagnostic accuracy tests were used to determine the sensitivity, specificity, predictive value and likelihood ratios of TIRADS in diagnosing malignancy detected by FNAB or histopathology. Odds ratios and the corresponding 95% confidence intervals from binary logistic regression was computed to determine the factors affecting discordance.

All valid data was included in the analysis. Missing values were neither replaced nor estimated. Null hypothesis was rejected at 0.05α-level of significance. STATA 15.0 was used for data analysis.

Results

We reviewed a total of 125 patients who underwent thyroidectomy (Table 1). By TIRADS, 99 of the subjects (79.2% of the population) had varying levels of risk for malignancy whether mild, moderate, and highly suspicious. By FNAC, 31 (24.8%) had biopsies that were suspicious (26 subjects) or overtly malignant (5 subjects). The rest of the FNAC results from Bethesda I to IV is seen on Table 3 wherein 64 (51.2% of the subjects) showed benign results. Thyroid Cancer was reported in 54 (43.2% of the population) patients.

Table 1. Diagnosis of thyroid malignancy according to test (n=125)

	n/N	% of Patient
By TIRADS (mild, moderate, high suspicion)	99/125	79.2
By Bethesda FNAC (suspicious for malignancy Category V, malignant Category VI)	31/125	24.8
Histopathology	54/125	43.2

Those with a histopathologic malignancy were younger, at an average age of 43.43 ± 12.99 years, compared to those with a benign diagnosis, at 49.45 ± 13.56 (p = 0.017).The majority (78.4%) of patients were female (Table 2). Total thyroidectomy was done for 100 (80%), total thyroidectomy with lymph node dissection for 20 (16%), and lobectomy for 5 (4%).

Nodule characteristics are enumerated on Table 3. Malignant nodules on histopathology had the following characteristics: 81.48% (vs 57.75%) were solid or almost completely solid, 62.96% (vs 19.72%) were hypoechoic, TIRADS that were mildly, moderately, and highly suspicious, FNAB that were suspicious for malignancy. The malignant nodules also had a higher proportion of taller than wide (12.96% versus zero), and ill-defined or irregular margins (more than 50%, while 66.2% had smooth margins).

Table 2. Profile of patients, by histopathology result (n=125)

	Total (n=125)	Malignant (n=54)	Benign (n=71)	p-value
	Mean ± SD; Frequency (%)			
Age, years	46.85 ± 13.6	43.43 ± 12.99	49.45 ± 13.56	**0.017***
≤45	59 (47.2)	30 (55.56)	29 (40.85)	0.103†
>45	66 (52.8)	24 (44.44)	42 (59.15)	
Sex				0.188†
Male	27 (21.6)	15 (27.78)	12 (16.9)	
Female	98 (78.4)	39 (72.22)	59 (83.1)	
Kind of operation				0.071†
Total thyroidectomy	100 (80)	40 (74.07)	60 (84.51)	
Lobectomy	5 (4)	1 (1.85)	4 (5.63)	
Total thyroidectomy with lymph node dissection	20 (16)	13 (24.07)	7 (9.86)	
Statistical tests used: * - Independent sample t-test; † - Fisher's Exact/Chi-square test				

Table 3. Association of Thyroid Ultrasound Characteristics and Histopathology Report (n = 125)

	Total (n=125)	Malignant (n=54)	Benign (n=71)	p-value
	Frequency (%); Median (Range)			
Solitary nodule	19 (15.2)	7 (12.96)	12 (16.9)	0.543†
Size (widest diameter), cm	2.1 (0.49–7.24)	2 (0.49–7.24)	2.1 (0.6–6.6)	0.791‡
Size (volume), cm^3	4.21 (0.12–237.6)	4.08 (0.14–237.6)	4.78 (0.12–115.2)	0.966‡
Location				0.807†
Left	55 (44)	25 (46.3)	30 (42.25)	
Right	62 (49.6)	25 (46.3)	37 (52.11)	
Isthmus	8 (6.4)	4 (7.41)	4 (5.63)	
Composition				**0.010†**
Cystic	8 (6.4)	0	8 (11.27)	
Spongiform	8 (6.4)	2 (3.7)	6 (8.45)	
Mixed cystic and solid	24 (19.2)	8 (14.81)	16 (22.54)	
Solid or almost completely solid	85 (68)	44 (81.48)	41 (57.75)	
Echogenicity				**<0.001†**
Anechoic	2 (1.6)	0	2 (2.82)	
Isoechoic or hyperechoic	75 (60)	20 (37.04)	55 (77.46)	
Hypoechoic	48 (38.4)	34 (62.96)	14 (19.72)	
Very hypoechoic	0	0	0	
Shape				**0.002†**
Wider than tall	118 (94.4)	47 (87.04)	71 (100)	
Taller than wide	7 (5.6)	7 (12.96)	0	
Margin				**0.008†**
Smooth	70 (56)	23 (42.59)	47 (66.2)	
Ill-defined	42 (33.6)	21 (38.89)	21 (29.58)	
Lobulated/irregular	13 (10.4)	10 (18.52)	3 (4.23)	
With extra-thyroidal extension	0	0	0	

TIRADS				**<0.001†**
Benign	13 (10.4)	1 (1.85)	12 (16.9)	
Not suspicious	13 (10.4)	1 (1.85)	12 (16.9)	
Mildly suspicious	34 (27.2)	10 (18.52)	24 (33.8)	
Moderately suspicious	38 (30.4)	22 (40.74)	16 (22.54)	
Highly suspicious	27 (21.6)	20 (37.04)	7 (9.86)	
FNAB (Bethesda)				**<0.001†**
I: No-diagnostic or Unsatisfactory	7 (5.6)	2 (3.7)	5 (7.04)	
II: Benign	64 (51.2)	6 (11.11)	58 (81.69)	
III: atypia of undetermined significance or follicular lesion of undetermined significance	10 (8)	7 (12.96)	3 (4.23)	
IV: (suspicious) for follicular neoplasm	13 (10.4)	10 (18.52)	3 (4.23)	
V: Suspicious for malignancy	26 (20.8)	24 (44.44)	2 (2.82)	
VI: Malignant	5 (4)	5 (9.26)	0	
Specific histopathology				-
Follicular Thyroid Cancer	12 (9.6)	12 (22.22)	0	
Papillary Thyroid Cancer	42 (33.6)	42 (77.78)	0	
Medullary Thyroid Cancer	0	0	0	
Anaplastic Thyroid Cancer	0	0	0	
Benign	71 (56.8)	0	71 (100)	

Statistical tests used: † - Fisher's Exact/Chi-square test; ‡ - Wilcoxon's rank-sum test

We assessed the diagnostic performance of TIRADS in comparison to FNAB and histopathology among patients with thyroid malignancy (Tables 4.1 and 4.2, respectively). Table 4 shows the diagnostic performance indicators of TIRADS compared to FNAB and histopathology as reference standards. Tables 4.1 and 4.2 show the specific breakdown for the diagnostic performance indicators.

Table 4. Summary of diagnostic performance of TIRADS in detecting malignancy using FNAB and histopathology

	TIRADS and FNAB	TIRADS and Histopathology
	% (95% CI), LR (95%CI)	
Sensitivity	100 (88.8–100)	96.3 (87.3–99.5)
Specificity	27.7 (18.9–37.8)	33.8 (23–46)
PPV	31.3 (22.4–41.4)	52.5 (42.2–62.7)
NPV	100 (86.8–100)	92.3 (74.9–99.1)
Positive LR	1.37 (1.2–1.56)	1.45 (1.22–1.73)
Negative LR	0.06 (0–0.89)	0.11 (0.03–0.44)
Accuracy	45.6 (36.67–54.75)	60.8 (51.67–69.41)
ROC area (area, 95% CI)	0.638 (0.59–0.68)	0.65 (0.59–0.71)

LR–Likelihood ratio; NPV–Negative predictive value; PPV–Positive predictive value; ROC: Receiver operating curve

With FNAB as a reference standard, TIRADS had good sensitivity and low specificity to detect thyroid malignancy. Among patients who are FNAB Category V and VI, TIRADS has sensitivity of 100% but a specificity of only 27.7%. Patients who are FNAB positive are 1.37 times more likely to yield a positive TIRADS compared to patients who are FNAB negative (LR+), and 94% less likely to yield a negative TIRADS result (LR-). PPV of TIRADS is 31.3% and NPV is nearly 100%. The accuracy of TIRADS in thyroid malignancy is 45.6%. The ROC area is at 0.638 (Table 4.1).

Table 4.1 Diagnostic accuracy of TIRADS in detecting malignancy on FNAB

	Malignancy/ Suspicious for malignancy on FNAB (+)	No diagnostic/Benign/ Atypia/ Suspicious for follicular neoplasm on FNAB (-)	Total
	Frequency (%)		
Mildly to highly suspicious on TIRADS (+)	31 (24.8)	68 (54.4)	99 (79.2)
Benign/not suspicious on TIRADS (-)	0	26 (20.8)	26 (20.8)
Total	31 (24.8)	94 (75.2)	125 (100)
Sensitivity (%, 95% CI)	100 (88.8–100)	Positive LR (LR, 95% CI)	1.37 (1.2–1.56)
Specificity (%, 95% CI)	27.7 (18.9–37.8)	Negative LR (LR, 95% CI)	0.06 (0–0.89)
PPV (%, 95% CI)	31.3 (22.4–41.4)	Accuracy (%, 95% CI)	45.6 (36.67–54.75)
NPV (%, 95% CI)	100 (86.8–100)	ROC area (area, 95% CI)	0.638 (0.59–0.68)
LR–Likelihood ratio; NPV–Negative predictive value; PPV–Positive predictive value Likelihood ratios were estimated using the substitution formula where 0.5 was added to all cell frequencies before calculation			

With histopathology as a reference standard, TIRADS had good sensitivity but low specificity to detect thyroid malignancy. Among patients who are histopathology positive, TIRADS has a sensitivity of 96.3% and has a specificity 33.8%. Patients who are histopathology positive are 1.45 times more likely to yield a positive TIRADS compared to patients who are histopathology negative (LR+), and 89% less likely to yield a negative TIRADS result (LR-). PPV of TIRADS is 52.5% and a NPV of 92.3%. The accuracy of TIRADS in thyroid malignancy is 60.8%. The ROC area was at 0.65. (Table 4.2).

Table 4.2 Diagnostic accuracy of TIRADS in detecting malignancy on histopathology

	Malignancy on histopathology (+)	Benign on histopathology (-)	Total
	Frequency (%)		
Mildly to highly suspicious on TIRADS (+)	52 (41.6)	47 (37.6)	99 (79.2)
Benign/not suspicious on TIRADS (-)	2 (1.6)	24 (19.2)	26 (20.8)
Total	54 (43.2)	71 (56.8)	125 (100)
Sensitivity (%, 95% CI)	96.3 (87.3–99.5)	Positive LR (LR, 95% CI)	1.45 (1.22–1.73)
Specificity (%, 95% CI)	33.8 (23–46)	Negative LR (LR, 95% CI)	0.11 (0.03–0.44)
PPV (%, 95% CI)	52.5 (42.2–62.7)	Accuracy (%, 95% CI)	60.8 (51.67–69.41)
NPV (%, 95% CI)	92.3 (74.9–99.1)	ROC area (area, 95% CI)	0.65 (0.59–0.71)
LR–Likelihood ratio; NPV–Negative predictive value; PPV–Positive predictive value			

The factors that are associated with discordant classification between TIRADS and FNAB are: those who underwent total thyroidectomy with lymph node dissection, and solid composition. Specifically, patients who underwent total thyroidectomy with lymph node dissection were nearly four times (cOR 3.84, 95% CI 1.2 to 12.3) more likely to have discordant classification between TIRADS and FNAB; and those with solid composition were 36 times (cOR 36.16, 95% CI 2.01 to 649) more likely to have discordant classification (Table 5.1).

Table 5.1 Factors of discordance in TIRADS and FNAB (n = 125)

	Discordant classification (n=68)	Concordant (both positive or both negative) (n=57)	Crude odds ratio (95% CI)	P-value
	Mean ± SD; Frequency (%); Median (Range)			
Age	48.299 ± 13.43	45.12 ± 13.71	1.018 (0.99–1.04)	0.194
Age categorized				
≤45	30 (44.12)	29 (50.88)	1.0 (Reference)	-
>45	38 (55.88)	28 (49.12)	1.312 (0.65–2.66)	0.451
Sex				
Male	10 (14.71)	17 (29.82)	1.0 (Reference)	-
Female	58 (85.29)	40 (70.18)	2.465 (1.02–5.94)	0.044
Kind of operation				
Total thyroidectomy	51 (75)	49 (85.96)	1.0 (Reference)	-
Subtotal thyroidectomy	0	0	-	-
Lobectomy	1 (1.47)	4 (7.02)	0.24 (0.03–2.23)	0.209
Total thyroidectomy with lymph node dissection	16 (23.53)	4 (7.02)	**3.843 (1.2–12.3)**	**0.023**
Solitary nodule	11 (16.18)	8 (14.04)	1.182 (0.44–3.17)	0.740
Size (widest diameter), cm	2.3 (0.49–7.24)	1.925 (0.6–6)	1.193 (0.93–1.54)	0.171
Size (volume), cm^3	5.59 (0.14–237.6)	3.4 (0.12–115.2)	1.007 (0.99–1.02)	0.327
Location				
Left	28 (41.18)	27 (47.37)	1.0 (Reference)	-
Right	38 (55.88)	24 (42.11)	1.527 (0.73–3.18)	0.259
Isthmus	2 (2.94)	6 (10.53)	0.321 (0.06–1.73)	0.187
Composition*				
Cystic	0	8 (14.04)	1.0 (Reference)	-
Spongiform	1 (1.47)	7 (12.28)	3.4 (0.12–96.7)	0.474
Mixed cystic and solid	9 (13.24)	15 (26.32)	10.419 (0.54–201.94)	0.121
Solid or almost completely solid	58 (85.29)	27 (47.37)	36.164 (2.01–649.36)	0.015
Echogenicity*				
Anechoic	0	2 (3.51)	1.0 (Reference)	-
Isoechoic or hyperechoic	39 (57.35)	36 (63.16)	5.411 (0.25–116.51)	0.281
Hypoechoic	29 (42.65)	19 (33.33)	7.564 (0.34–166.2)	0.199
Very hypoechoic	0	0	-	-
Shape				
Wider than tall	67 (98.53)	51 (89.47)	1.0 (Reference)	-
Taller than wide	1 (1.47)	6 (10.53)	0.127 (0.01–1.09)	0.060
Margin				
Smooth	42 (61.76)	28 (49.12)	1.0 (Reference)	-
Ill-defined	21 (30.88)	21 (36.84)	0.667 (0.31–1.44)	0.303
Lobulated/irregular	5 (7.35)	8 (14.04)	0.417 (0.12–1.4)	0.158
With extra-thyroidal extension	0	0	-	-

Concordant means same diagnosis on both TIRADS and FNAB (both malignant or both non-malignant)
Statistical test used: Logistic regression * Calculated using Firth logistic regression

We have insufficient evidence to determine whether any of the patient or nodule characteristics were associated with discordance between TIRADS and histopathology

Table 5.2 Factors of discordance in TIRADS and Histopathology

	Discordant classification (n=49)	Concordant (both positive or both negative) (n=76)	Crude odds ratio (95% CI)	P-value
	Mean ± SD; Frequency (%); Median (Range)			
Age	48.82 ± 13.87	45.58 ± 13.35	1.018 (0.99–1.05)	0.194
Age categorized				
≤45	22 (44.9)	37 (48.68)	1.0 (Reference)	-
>45	27 (55.1)	39 (51.32)	1.164 (0.57–2.39)	0.679
Sex				
Male	6 (12.24)	21 (27.63)	1.0 (Reference)	-
Female	43 (87.76)	55 (72.37)	2.736 (1.02–7.37)	0.047
Kind of operation				
Total thyroidectomy	40 (81.63)	60 (78.95)	1.0 (Reference)	-
Subtotal thyroidectomy			-	-
Lobectomy	2 (4.08)	3 (3.95)	1.0 (0.16–6.25)	>0.999
Total thyroidectomy with lymph node dissection	7 (14.29)	13 (17.11)	0.808 (0.3–2.2)	0.676
Solitary nodule	9 (18.37)	10 (13.33)	1.485 (0.56–3.97)	0.430
Size (widest diameter), cm	2.1 (1–6.6)	2.1 (0.49–7.24)	0.962 (0.75–1.23)	0.758
Size (volume), cm3	4.6 (0.34–101.68)	4.2 (0.12–237.6)	0.993 (0.98–1.01)	0.366
Location				
Left	20 (40.82)	35 (46.05)	1.0 (Reference)	-
Right	28 (57.14)	34 (44.74)	1.441 (0.69–3.03)	0.335
Isthmus	1 (2.04)	7 (9.21)	0.25 (0.03–2.18)	0.210
Composition*				
Cystic	0	8 (10.53)	1.0 (Reference)	-
Spongiform	1 (2.04)	7 (9.21)	3.4 (0.12–96.7)	0.474
Mixed cystic and solid	7 (14.29)	17 (22.37)	7.286 (0.37–143.11)	0.191
Solid or almost completely solid	41 (83.67)	44 (57.89)	15.854 (0.89–283.37)	0.060
Echogenicity*				
Anechoic	0	2 (2.63)	1.0 (Reference)	-
Isoechoic or hyperechoic	35 (71.43)	40 (52.63)	4.383 (0.2–94.37)	0.345
Hypoechoic	14 (28.57)	34 (44.74)	2.101 (0.09–46.54)	0.638
Very hypoechoic	0	0	-	-
Shape*				
Wider than tall	49 (100)	69 (90.79)	1.0 (Reference)	-
Taller than wide	0	7 (9.21)	-2.369 (-5.25–0.52)	0.108
Margin				
Smooth	28 (57.14)	42 (55.26)	1.0 (Reference)	-

Ill-defined	18 (36.73)	24 (31.58)	1.125 (0.52–2.44)	0.766
Lobulated/irregular	3 (6.12)	10 (13.16)	0.45 (0.11–1.78)	0.255
With extra-thyroidal extension	0	0	-	-

Concordant means same diagnosis on both TIRADS and FNAB (both malignant or both non-malignant)
Statistical test used: Logistic regression
*Calculated using Firth logistic regression

Discussion

Fine Needle Aspiration biopsy (FNAB) is currently the first line in diagnosing and evaluating thyroid nodules. Based on the results of the study, when compared to FNAB, TIRADS has good sensitivity but low specificity to detect thyroid neoplasm. If histopathology is used as a reference, the TIRADS still showed high sensitivity but low specificity. TIRADS has fair discriminative power to differentiate between benign versus malignant thyroid nodules. Discordants that may be involved when correlating TIRADS and FNAB include those who underwent total thyroidectomy with lymph node dissection and if the suspected nodule is of solid component.

In a study done by Tan, et al, TIRADS classification especially with a score of 4 exhibited the highest diagnostic value for thyroid cancer; with a sensitivity of 92.7% and specificity of 70.7%. Additionally, the Bethesda classification with a score of 3 exhibited the highest diagnostic value for thyroid cancer; with a sensitivity of 90% and specificity of 94.3%. when combined, their sensitivity increased to 97.3% and the specificity was 92.0%[10]. With our study, the results only showed only high sensitivity which is 96.3% but low specificity at 33.8%.

In another study done by Kwak, et al, entitled "Value Of Ultrasound Correlation Of A Thyroid Nodule With Initially Benign Cytologic Results", it showed that among highly suspicious ultrasound findings of thyroid nodules, the false-negative rate is high in correlation with their cytological examination results. Cytological examination results of benign nodules indicated that the malignant rate could be as high as 29% if the ultrasonography was suspicious, but only 0.6% if the ultrasound result was normal[11]. The incidence of false negativity may be due to nature of the lesions, intrinsic limitations of the procedure, and the manner, skill, and experience of the operator. Since TIRADS is a new method used in evaluating thyroid nodules in our institution, false negativity and false positivity may vary.

Though the result of this study showed a low specificity of using TIRADS in detecting malignancy for thyroid nodules as compared with the study of Tan, et al, but due to its high sensitivity which is higher compared to the same study, TIRADS classification is a very good tool in ruling out the presence of malignancy. TIRADS classification is very helpful and systematic evaluation of thyroid nodules. It will help physicians in deciding the next step in the management and in giving advice to patients. It can provide a comprehensive picture in giving prognosis to patients.

Some limitations of this study include a possible selection bias due to its retrospective design. TIRADS classification system is a new diagnostic tool that has been utilized in our institution leading to a limited sample of subjects. A bigger sample size will strengthen the power of the study. Furthermore, combining TIRADS with FNAB will yield a better idea on the characteristic of the thyroid nodule. In addition, a prospective study may be warranted following patients with thyroid nodules to be evaluated with TIRADS first then undergoing FNAB then correlating it with the histopathological results.

Conclusion

In conclusion, TIRADS classification has very good sensitivity in detecting thyroid malignancies but has fair discriminative power to differentiate between benign versus malignant thyroid nodules. Factors that are associated with discordant classification between TIRADS and FNAB are those who underwent total thyroidectomy with lymph node dissection, and solid composition. There is insufficient evidence to determine whether any of the patient or nodule characteristics were associated with discordance between TIRADS and histopathology.

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