ORIGINAL ARTICLE

# Evaluation of Concordance of Ultrasound, Cytology, and Histopathology in Solitary Thyroid Nodules

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*Received on:* 12 April 2023; *Accepted on:* 04 May 2023; *Published on:* 30 June 2023

## Abstract

**Introduction:** The American College of Radiology (ACR)-Thyroid Imaging and Reporting Data System (TIRADS) is used to classify the ultrasound (USG) findings and the Bethesda System for Reporting Thyroid Cytopathology (TBSRTC) is used to classify the fine needle aspiration (FNAC) findings for a solitary thyroid nodule (STN).

**Objective:** The objective of this study is to assess the concordance between TIRADS and TBSRTC with final postoperative histopathology in cases of STN and to calculate the risk of malignancy (ROM).

**Materials and methods:** The prospective observational study was conducted at a tertiary care hospital in India. Patients underwent USG and FNAC before undergoing surgery. Final concordance was analyzed with histopathology examination.

**Results:** The study included 80 subjects. The ROM for the TIRADS categories was 25.92%, 65.21%, and 100% for TIRADS (TR)3, TR4, and TR5 nodules, respectively. The ROM for Bethesda categories was 0% for Bethesda (B) I (BI), 6.5% for BII, 47.36% for BIII, 46.67% for BIV, and 100% for BV and BVI. Concordance was calculated using the kappa index, which was 0.21 with SE = 0.08 and 95% confidence interval (CI) = 0.061–0.359. After broad categorization, the re-calculated kappa was 0.38 with SE = 0.09 (95% CI: 0.203–0.564) with the observed agreement of 64% and by chance agreement of 41.6%.

**Conclusion:** There is fair concordance between ACR-TIRADS and TBSRTC. Indeterminate concordant and discordant nodules mandate a closer look owing to the high ROM.

**Keywords:** Bethesda, Concordance, Risk of malignancy, Solitary thyroid nodule, Thyroid Imaging and Reporting Data System.

*Indian Journal of Endocrine Surgery and Research* (2023): 10.5005/jp-journals-10088-11204

## Introduction

The disorders of the thyroid gland are the second most common endocrine dysfunction in the world after diabetes. They present commonly to an endocrine surgeon with a thyroid swelling. The prevalence of these swellings is dependent on the method of identification. The estimated prevalence by palpation alone ranges from 4 to 7%[1] compared to the ultrasound (USG) detection rate of 20–76% in adult population.[2,3] The gold standard test for the identification of nodules is the high-resolution USG.[4] A single USG feature in isolation is not capable of predicting malignancy in these nodules.[5] Therefore, in order to permit USG imaging for the identification and stratification of nodules in terms of risk of malignancy (ROM), several guidelines have been developed. The American College of Radiology (ACR)-Thyroid Imaging and Reporting Data System (TIRADS) is developed and validated based on existing multi-institutional data and expert opinion.[6] In this system, each of six characteristics of thyroid nodule are evaluated and individual score is given to each category. The sum of individual scores gives the total score. The total score is then used to stratify the nodule into five categories equivalent to normal, benign, probably benign, suspicious, and malignant. Higher the score, more is ROM. Cytological evaluation of thyroid swellings is a rapid, easy, and inexpensive diagnostic procedure. But in view of the lack of uniformity in the reporting systems used across the world and to improve pathologist–clinician communication, The Bethesda System for Reporting Thyroid Cytopathology (TBSRTC) was introduced in 2007 and subsequently revised in 2017.[7,8] The TBSRTC classifies all thyroid aspirates into six categories, with each category having an associated ROM and guidelines for management.

Mere diagnosis of thyroid nodule causes anxiety to the patient and the desire to know the ROM in nodule and further management plan. If we can confidently make preoperative diagnosis of benign or malignant nodule, this will help in putting the brakes on unnecessary thyroidectomies in benign asymptomatic thyroid nodules and simultaneously not leaving behind the malignancy. There are various studies validating the TIRADS[9–11] and TBSRTC systems[2,12,13] individually demonstrating very good sensitivity and good specificity. Most of studies utilize fine needle aspiration (FNAC) diagnosis to validate USG results but FNAC is not a gold standard.[11,14] Very few such studies in Indian population are available. Only a handful of authors have evaluated concordance of

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**How to cite this article:** Rathore YS, Puri G, Yadav S, *et al.* Evaluation of Concordance of Ultrasound, Cytology, and Histopathology in Solitary Thyroid Nodules. Indian J Endoc Surg Res 2023;18(1):17–23.

**Source of support:** Nil

**Conflict of interest:** None

the two systems with each other using histopathology as the final diagnosis.[15] Hence, we conducted this prospective observational study in a cohort of solitary thyroid nodules (STN), with the objective of comparing the TIRADS and TBSRTC with the final diagnosis as made on histopathology.

## Materials and Methods

### Study Design

This is a prospective observational study. All the patients presenting with thyroid swelling in surgery outpatient department were assessed and patients with STN were recruited in the study after informed written consent.

### Objective

The objective of this study was to assess the concordance between the TIRADS and TBSRTC with final postoperative histopathology in cases of STN with calculation of ROM in each category.

### Inclusion Criteria

The inclusion criteria for this study are as follows:

- Patient with STN
- Age >12 years with patients aged 12–18 years after the consent of parents

### Exclusion Criteria

The inclusion criteria for this study are as follows:

- Patients with thyrotoxicosis
- Patients with small (<1 cm) STN managed conservatively
- Patient unfit for surgery

### Sample Size

The sensitivity of both the diagnostic tests (TIRADS and TBSRTC) is high (80–97%) as observed previously in different studies, and the specificity of these tests is 50–70% and 60–95%, respectively. Considering the TIRADS and TBSRTC as two independent proportions in order to detect the significant difference in specificity (as compared to histopathology, 70% vs 90%), we required 82 histopathologically negative cases for our study with 90% power. To get 82 histopathologically negative (i.e., benign) cases, we required 92 cases of thyroid swelling. We proposed a sample size of 100 for our study, considering the malignancy rate in thyroid swelling as 10% according to various studies.

### Workup

All patients underwent sonography of the neck at the Department of Radiodiagnosis with a superficial 7–15 MHz linear transducer and categorized as per ACR-TIRADS. Then, patients underwent USG-guided FNAC of the thyroid nodule based on American Thyroid Association (ATA) guidelines,[16] and cytology smears were assessed and categorized as per TBSRTC system.[8] The patient underwent preoperative workup including thyroid profile and indirect laryngoscopy along with routine investigations. Hemithyroidectomy was performed in nodules with Bethesda (B) II (BII, >1 cm when the patient wants surgery), BIII, and BIV. The indications for total thyroidectomy (TT) were: FNAC-proven carcinoma (BV and BVI), FNAC-proven papillary carcinoma thyroid, with the size of nodule more than 1 cm, and intraoperative decision where infiltration of surrounding structures seen suggesting carcinoma. Postoperatively, the patients undergoing hemithyroidectomy were discharged next day. And those underwent TT were observed for hypocalcemia and were discharged accordingly. The thyroidectomy specimens were sent to the Department of Pathology for routine processing. It was fixed in neutral buffered formalin. Appropriate sections were taken from the nodule, its capsule, and adjoining thyroid. The sections were paraffin-embedded, and then viewed and reported by an expert pathologist. The correlation between the TIRADS and Bethesda grading was established with final histopathology.

### Statistics and Data Analysis

Data were entered and analyzed with Stata software. The ROM in each group was calculated. The ROM was expressed in percent for each of the Bethesda diagnostic category that was determined by dividing the total number of histologically confirmed malignant cases by the number of cases with surgical follow-up within the TBSRTC category. For the risk of neoplasm (RON), histologically confirmed benign neoplasms and tumors of uncertain malignant potential were also added to the numerator. The concordance was calculated using the Cohen's kappa statistic with agreement between the USG and cytology taking histopathology as gold standard. A qualitative stratified analysis was performed for the agreement and disagreement between the two modalities and ROM in these concordant and discordant nodules.

## Results

A total of 140 patients were considered for recruitment, with a clinically palpable STN out of which 30 patients had more than one nodule on USG and were excluded. Further, 16 refused consent to undergo further investigations and were excluded. Out of the remaining 94 patients, 90 had an operable nodule and were recruited in the study. However, due to the limited availability of the routine operation theater (OT) in the COVID-19 pandemic, only 80 patients were operated, and their data were analyzed.

Of the total 80 study subjects, 66 (82.5%) were females and 14 (17.50%) were males. Almost two-thirds of patients (65%) were in the age group of 20–40 years (Table 1). Nine (10.12%) patients were hypothyroid. Two patients had comorbidities (coronary artery disease) other than hypothyroidism. Three patients had family history of thyroid disorder as hypothyroidism. None had the history of thyroid malignancy. Also, no patient had the history of radiation exposure. The nodule was more common on the left side 54 (67.50%) than the right side 26 (32.50%). Cervical lymph nodes were present in 5 (6.25%) patients. None of the patient had retrosternal extension or tracheal deviation and/or compression.

The USG findings were noted as per the ACR-TIRADS category. Among total study population, 24 (30%) nodules were categorized as TR2, 27 (33.75%) in TR3, 23 (28.75%) in TR4, and 6 (7.50%) in TR5 category. On the initial cytology examination, there were eight cases, which were unsatisfactory for evaluation. On repeat aspiration, three were recategorized into higher categories. The final distribution of cases into the various Bethesda categories is depicted in Table 1. There were 31 (38.75%) patients with benign cytology (BII), 19 (23.75%) with BIII, 15 (18.70%) with BIV, 1 (1.25%) with BV, and 9 (11.25%) with BVI. The surgery performed is summarized in Table 1 with majority (82.5%) undergoing hemithyroidectomy. Out of these, 14 (21.21%) revealed malignancy and hence underwent completion thyroidectomy.

**Table 1:** Baseline characteristics and their distribution among the study population

| *Baseline characteristics* | *Number of patients (n = 80)* |
|---|---|
| Gender | |
| Male | 66 (82.5%) |
| Female | 14 (17.5%) |
| Age | |
| <20 years | 3 (3.75%) |
| 20–40 years | 52 (65%) |
| 40–60 years | 19 (23.75%) |
| >60 years | 6 (7.5%) |
| Presenting complaints | |
| Swelling | 80 (100%) |
| Pain | 32 (40%) |
| Globus sensation | 16 (20%) |
| Dyspnea | 8 (10%) |
| Dysphagia | 14 (17.5%) |
| Hoarseness | 8 (10%) |
| TIRADS categories | |
| TIRADS 2 | 24 (30%) |
| TIRADS 3 | 27 (33.75%) |
| TIRADS 4 | 23 (28.75) |
| TIRADS 5 | 6 (7.5%) |
| TBSRTC categories | |
| BI | 5 (6.25%) |
| BII | 31 (38.75%) |
| BIII | 19 (23.75%) |
| BIV | 15 (18.75%) |
| BV | 1 (1.25%) |
| BVI | 9 (11.25%) |
| Surgery performed | |
| Hemithyroidectomy | 66 (82.5%) |
| Open | 59 |
| Endoscopic | 7 |
| Only TT | 9 (11.25%) |
| TT plus CCLND | 2 (2.5%) |
| TT plus MRND | 3 (3.75%) |
| Completion thyroidectomy* | 14 (21.21%) |
| Final histopathology | |
| Benign | 52 (65%) |
| Malignant | 28 (35%) |

CCLND, central compartment lymph node dissection; MRND, modified radical neck dissection. *Completion thyroidectomy was performed 6–8 weeks after the primary surgery, and the percentage is calculated taking the total number of hemithyroidectomy as the denominator

## Risk of Malignancy

The ROM was calculated as a percentage of the nodules that were malignant over the total nodules. The RON was defined considering Non-invasive follicular thyroid neoplasm with papillary like nuclear features (NIFTP) and adenomas in addition to malignant cases. The malignancy rate according to the gender, age, TIRADS, and Bethesda classification is depicted in Table 2. The TR3 nodules had 25.92% ROM. The ROM in TR4 nodule was noted to be 65.21% and 100% for TR5 nodules. None of the BI aspirates turned out to be malignant on histopathology. Two of the 31 (6.5%) nodules in BII showed a malignant histopathology. The ROM in BIII and IV was 9/19 (47.36%) and 7/15 (46.67%), respectively. All nodules in BV and BVI were malignant with 100% ROM. Final histopathology stratified with preoperative FNAC findings is depicted in Table 3. The non-neoplastic swellings were seen in 38 (47.5%) patients compared to 9 (11.3%) benign neoplasms (5 follicular adenoma and four hurtle cell adenoma), 5 (6.3%) NIFTP, and 28 (35%) malignant neoplasm. Among malignant pathology, there were 27 (96.4%) papillary thyroid carcinoma (PTC) (including one focus papillary microcarcinoma) and one was poorly differentiated carcinoma. Of the 27 PTCs, 18 (66.67%) were classical variants, 5 (18.51%) were follicular variants, 2 (7.4%) were solid variant, 1 (3.7%) is hobnail, and 1 (3.7%) was tall cell variant.

**Table 2:** ROM in relation to the respective parameters

| *Characteristics* | *Calculation of ROM* | *ROM* |
|---|---|---|
| Gender | | |
| Male | 5/14 | 35% |
| Female | 23/66 | 34.85% |
| Age | | |
| <20 years | 1/3 | 33.33% |
| 20–40 years | 23/52 | 44.23% |
| 40–60 years | 3/19 | 15.78% |
| >60 years | 1/6 | 16.67% |
| TIRADS categories | | |
| TIRADS 2 | 0/24 | 0% |
| TIRADS 3 | 7/27 | 25.92% |
| TIRADS 4 | 15/23 | 65.21% |
| TIRADS 5 | 6/6 | 100% |
| TBSRTC categories | | |
| BI | 0/5 | 0% |
| BII | 2/31 | 6.45% |
| BIII | 9/19 | 47.36% |
| BIV | 7/15 | 46.67% |
| BV | 1/1 | 100% |
| BVI | 9/9 | 100% |

## The Concordance of the TIRADS and Bethesda

The concordance was calculated after excluding the BI category and then equating the TR2 with BII, TR3 with BIII, TR4 with BIV, and TR5 with BV plus BVI. The distribution of cases as per their sonographic categories and their FNAC findings along with the rate of malignancy is depicted in Table 4 (BI was mentioned for the calculation of ROM and included in the TIRADS test analysis but withdrawn from the FNAC test analysis). The linear weighted Cohen's kappa index was calculated to be 0.21, with SE = 0.08 and 95% confidence interval (CI) = 0.061–0.359. The observed and expected (by chance) agreements were 42.67% and 27.43%, respectively. For better clinical application, the concordance was again calculated after re-grouping of the Bethesda and TIRADS categories into three broad groups: benign, indeterminate, and malignant groups (Table 5). The nodules with TR2 and BII were grouped in the benign group. Those with TR3, 4 and BIII, IV were categorized in the indeterminate group. The TR5 and BV, and VI

**Table 3:** Stratified analysis of the FNAC findings with the final histopathology along with ROM and RON

| | *BI* | *BII* | *BIII* | *BIV* | *BV* | *BVI* | *Total (n = 80)* |
|---|---|---|---|---|---|---|---|
| Adenomatous goiter | 3 | 26 | 6 | 1 | 0 | 0 | 36 (45.0%) |
| Thyroiditis | 0 | 1 | 1 | 0 | 0 | 0 | 2 (2.5%) |
| Adenoma | 1 | 1 | 2 | 5 | 0 | 0 | 9 (11.25%) |
| NIFTP | 1 | 1 | 1 | 2 | 0 | 0 | 5 (6.25%) |
| Carcinoma | 0 | 2 | 9 | 7 | 1 | 9 | 28 (35%) |
| Total | 5 | 31 | 19 | 15 | 1 | 9 | 80 |
| RON* | 2/5 (40%) | 4/31 (12.9%) | 12/19 (63.2%) | 14/15 (93.3%) | 1/1 (100%) | 9/9 (100%) | 42/80 (52.5%) |
| ROM | 0/5 (0%) | 2/31 (6.45%) | 9/19 (47.36%) | 7/15 (46.67%) | 1/1 (100.0%) | 9/9 (100.0%) | 28/80 (35%) |

*RON, the risk of neoplasia calculated including the benign neoplastic swellings such as NIFTP and adenomas

**Table 4:** Concordance of USG findings with the cytology

| *FNAC/USG* | *TR2* | *TR3* | *TR4* | *TR5* | *Total* | *Malignancy* |
|---|---|---|---|---|---|---|
| BI | 2 | 3 | 0 | 0 | 5 | 0/5 (0.0%) |
| BII | 17 | 8 | 6 | 0 | 31 | 2/31 (6.5%) |
| BIII | 4 | 7 | 8 | 0 | 19 | 9/19 (47.4%) |
| BIV | 1 | 8 | 4 | 2 | 15 | 7/15 (46.7%) |
| BV | 0 | 0 | 0 | 1 | 1 | 1/1 (100.0%) |
| BVI | 0 | 1 | 5 | 3 | 9 | 9/9 (100.0%) |
| Total | 24 | 27 | 23 | 6 | 80 | 28/80 |
| Malignancy | 0/24 (0.0%) | 6/27 (22.2%) | 15/23 (71.4%) | 6/6 (100.0%) | 28/80 | 35.0% |

**Table 5:** Qualitative analysis of concordance of the TIRADS with TBSRTC with ROM

| *Groups* | *TIRADS* | *Bethesda* | *Concordant nodules (agreement)* | *ROM in Concordant nodules* | *Discordant nodules (disagreement)* | *ROM in discordant nodules* |
|---|---|---|---|---|---|---|
| Simple groups | | | | | | |
| Benign | TR2 ($n = 22$) | BII | 17 (77.27%) | 0 | 5 (22.72%) | 0 |
| Indeterminate | TR3 ($n = 24$) | BIII | 7 (29.16%) | 3 (42.85%) | 17 (70.83%) | 3 (17.64%) |
| | TR4 ($n = 23$) | BIV | 4 (17.39%) | 3 (75%) | 19 (82.61%) | 11 (57.89%) |
| Malignant | TR5 ($n = 6$) | BV and BVI | 4 (66.67%) | 4 (100%) | 2 (33.33%) | 2 (100%) |
| Composite indeterminate group | TR3 and TR4 ($n = 47$) | BIII and BIV | 27 (57.44%) | 13 (48.15%) | 20 (42.55%) | 8 (40%) |

were grouped as malignant groups. The re-calculated kappa is 0.38 with SE = 0.09 (95% CI: 0.203–0.564). The observed agreement is 64% of observation and that by chance is 41.6% of observation. In this study, weighted kappa is 0.451. Hence, the calculated agreement between the two tests ranged from 0.2 to 0.4, indicating a fair level of concordance. A simultaneous qualitative analysis was done to calculate the percentage of concordance as depicted in Table 5. The percentage of agreement was highest in the TR2–BII group at 77.27% followed by malignant group at 66.67%. The agreement in the TR3–BIII group was 29.16% and for TR4–BIV, it was 17.39%. After analyzing them as a composite group with indeterminate malignant potential, the agreement improved to be 57.44%. The ROM among the indeterminate group was 48.15% in the concordant nodules and 40% in the discordant nodules. The ROM in discordant nodules of other groups is shown in Table 5.

## Discussion

The prevalence of thyroid nodules is ever increasing because of the advanced imaging modalities. The significance of thyroid swelling lies in the ROM, which is higher in the STN. In the solitary thyroid nodules, the incidence of malignancy ranges from 10 to 21%, as shown in one of the studies.[17] Recent studies demonstrate higher incidence of malignancy, i.e., 20–45%.[18] In our study, we observed 35% malignancy rate in STNs correlating with the recent literature. The incidence of thyroid nodules increases with age. One of the studies showed that only 12.9% of those younger than 30 years had a nodule(s) compared to 50–70% of patients older than 70 years and they had more prevalence of multiple nodules.[19,20] In contrast, we had 65% of patients in 20–40 years age group, the young and productive population of the society. The incidence in extremes of ages is less (3.75% in <20 years and 7.5% in >60 years) than those mentioned in the literature. Also, the malignancy was most frequent (53%) in the age group of 20–30 years. A recent study from India has demonstrated increasing incidence of thyroid nodules and more so in younger (<45 years) population.[21] There has been noted up to four times higher incidence of nodules in women than men.[2] Two-thirds of patients in our study with STN were females. The literature also describes the majority of population as females from 60 to 90% of population with thyroid nodule. The gender disparity,

**Table 6:** ROM reported in various studies with the TIRADS

| *ROM on TR* | *TR2* | *TR3* | *TR4* | *TR5* |
|---|---|---|---|---|
| Russ et al.[23] | 0 | 0.25% | 6–60% | 100% |
| Chandramohan et al.[24] | 6.6% | 32.0% | 36.0–64.0% | 91.0% |
| Hovarth et al.[25] | 0 | 14.0% | 45.0% | 89.6% |
| Park et al.[26] | 9.6% | 31.1% | 76.8% | 100.0% |
| Jabar et al.[10] | 0 | 6.9% | 30.9% | 77.7% |
| Al Dawish et al.[27] | 15.5% | 13.3% | 26.3–48.3% | 75.6% |
| Srinivas et al.[28] | 0.6% | 4.8% | 76–66.7% | 100.0% |
| Our study | 0 | 25.92% | 65.21% | 100.0% |

**Table 7:** ROM and RON reported in various studies for the TBSRTC

| *ROM* | *BI* | *BII* | *BIII* | *BIV* | *BV* | *BIV* |
|---|---|---|---|---|---|---|
| Agarwal and Jain[30] | 15% | 3% | 34% | 26% | 69% | 94% |
| Cibas et al.[34] | 1–4% | 0–3% | 5–15% | 15–30% | 60–75% | 97–99% |
| Cibas and Ali[8]* | 5–10% | 0–3% | 6–18% | 10–40% | 45–60% | 94–96% |
| Bongiovanni et al.[29] | 16.8% | 3.7% | 15.9% | 26.1% | 75.2% | 98.6% |
| Poller et al.[31] | 12% | 5% | 25% | 31% | 79% | 98% |
| Inabnet et al.[32] | 19.2% | 12.7% | 31.9% | 31.4% | 77.8% | 96% |
| Our study | (0%) | (6.45%) | (47.37%) | (46.67%) | (100%) | (100%) |
| *RON* | *BI* | *BII* | *BIII* | *BIV* | *BV* | *BVI* |
| Chen et al.[33] | 38.3% | 20.9% | 63.2% | 83.9% | 94% | 100% |
| Agarwal and Jain[30] | 34% | 8% | 62% | 81% | 76% | 95% |
| Our study | 40% | 12.9% | 63.2% | 93.3% | 100.0% | 100% |

*ROM was calculated considering NIFTP as malignant

which is a common theme throughout the endocrine surgery, can be explained by the variation of the hormonal influences of both estrogen and progesterone. This is further evidenced by the increase in the size of the nodules as well as the development of new nodules in pregnancy and in multiparous females.[22]

With the recent advancement of high frequency sonography, it has become the first investigation for thyroid nodules. Among diverse classifications, ACR-TIRADS is preferred to formulate standardized system, which is used in our study. The sonography findings are categorized more than one-third nodules in benign (TR2) group and only 7.5% in definitive malignant (TR5) category. Almost two-thirds of nodules were indeterminate (TR3, 4). The calculated ROM in each TIRADS category was 0% in TR2 and 25.92% in TR3, 65.21% in TR4, and 100% in TR5. In a recent prospective study in India, the ROM in ACR TI-RADS category 1 and 2 were found to be 0%, 6.9% in category 3, 30.9% in category 4, and 77.7% in category 5.[10] There is a plethora of literature in different thyroid sonography reporting systems. These have validated the respective TIRADS comparing them with FNAC findings. Whereas in our study, we have calculated ROM with respect to final histopathology of thyroidectomy specimen. The ROM in different TIRADS categories in various studies are tabulated below (Table 6).[10,23–28] It is important to note that there is a wide variation in the study groups compared, as they are based on different TIRADS systems. The last two recent studies have used the ACR-TIRADS. The current study is in concordance with these studies and with a recent study from Indian (Srinivas et al.) with higher ROM in our study (25.92% vs 4.7%) in TR3 group.[28] So, TR2 nodules can be confidently classified as benign nodule and those TR5 can be confidently managed as malignancy. The nodules in indeterminate category remain difficult for decision making. In our study, diagnostic hemithyroidectomy was considered depending on the FNAC results and patient preference.

The FNAC is the safe, easy method with good sensitivity, and so is the standard of care in thyroid nodule evaluation.[8] The findings are reported as described in the standard reporting system, TBSRTC. In our study, Bethesda category I was also observed in five patients even on repeated aspiration. These nondiagnostic categories were then subjected to hemithyroidectomy depending on the TIRADS category and discussion with patient. In a meta-analysis, the distribution of patients in different categories is 12.9% in B1, 59.3% in BII, 9.6% in BIII, 10.1% in BIV, 2.7% in BV, and 5.4% in BVI. More than half of patients were benign on cytology.[29] Whereas in our study, we have 38.75% in BII, 23.25% in BIII, 18.75% in BIV, 1.25% in BV, and 11.25% in BVI. It is similar to the data from a meta-analysis of FNAC results in Indian data.[30] The ROM is higher in our study comparing to other studies, especially in the indeterminate category (BIII and BIV). This can be attributed to the small sample size and a cohort of STNs is known to have higher ROM. A detailed comparison is made in Table 7.[8,29–34] Up to 17% malignancy rate has been described in nondiagnostic category (BI) in the literature. This is much higher than proposed by the TBSRTC (1–4%).[29,34]

The study results show fair concordance in the two tests specifically in the definitive benign and malignant group. The agreement reached as high as 77.27% for TR2 and BII nodules and

as low as 17.39% for TR4 and BIV nodules. Even though there were discordant nodules in the TR2 group, the malignancy risk was zero. The agreement in the TR5 group was at 66.67% with a 100% malignancy risk in both concordant and discordant nodules. Thus, there were no malignant cytology in sonographically benign nodule and there was no benign histology on sonographically malignant nodules in our study. As a common theme noticed in the literature, the higher concordance rates were noted at the extremes, that is, the lowest risk (TIRADS 2 and BII) and the highest risk categories (TIRADS 4 and BIV).[35] This can be safely interpreted as the nodules given a low risk on the sonography have a lower probability of being malignant on the cytology as compared to those given a high-risk stratification on the sonography.[15] Our study demonstrated a fair concordance with a kappa value of 0.021 and 46% agreement compared to a recent study concluding good concordance with kappa value of 0.4 and 60% agreement.[15] One more recent study has established good concordance in all categories of the TIRADS with histopathology with slightly higher ROM in TR2.[36]

In the present study, the TIRADS system was most concordant with the Bethesda system in benign (TR2 and BII) and malignant (TR5 and BV/VI) category. In this group, they were also most concordant with the final histopathology with 100% agreement. In the indeterminate group, the agreement was low when analyzed as two separate groups and improved with a composite group formation. This was because these TR3,4 and BIII, BIV form a large chunk of nodules with varied ROM and remain an entity poorly understood. There is a role of molecular testing in these nodules to stratify the ROM but that is too expensive to be available to the general population in the Indian set-up and thus beyond the scope of this study. The USG criteria may help to decide cost-effective management.[8] There was a high likelihood of nodule to be malignant if both sonography and cytology showed high-risk features. The ROM was high in both concordant and discordant indeterminate nodules, thus warranting a comprehensive evaluation in the form of repeat testing, molecular testing, or diagnostic hemithyroidectomy.

## Conclusion

The study demonstrates a fair concordance between the ACR-TIRADS and TBSRTC. However, there was thorough concordance for BII–TR2 category with low ROM and TRV–BV/VI category with high ROM. Indeterminate nodules on the other hand, create a challenging grey area with relatively high ROM.

## References


1. Singer PA, Cooper DS, Daniels GH, et al. Treatment guidelines for patients with thyroid nodules and well-differentiated thyroid cancer. American Thyroid Association. Arch Intern Med 1996;156(19): 2165–2172. DOI: 10.1001/archinte.156.19.2165.
2. Mazzaferri EL. Management of a solitary thyroid nodule. N Engl J Med 1993;328(8):553–559. DOI: 10.1056/NEJM199302253280807.
3. Ezzat S, Sarti DA, Cain DR, et al. Thyroid incidentalomas. Prevalence by palpation and ultrasonography. Arch Intern Med 1994;154(16): 1838–1840. DOI: 10.1001/archinte.154.16.1838.
4. Mistry R, Hillyar C, Nibber A, et al. Ultrasound classification of thyroid nodules: A systematic review. Cureus 2020;12(3):e7239. DOI: 10.7759/cureus.7239.
5. Remonti LR, Kramer CK, Leitão CB, et al. Thyroid ultrasound features and risk of carcinoma: A systematic review and meta-analysis of observational studies. Thyroid 2015;25(5):538–550. DOI: 10.1089/thy.2014.0353.
6. Middleton WD, Teefey SA, Reading CC, et al. Multiinstitutional analysis of thyroid nodule risk stratification using the American College of Radiology Thyroid Imaging Reporting and Data System. Am J Roentgenol 2017;208(6):1331–1341. DOI: 10.2214/AJR.16.17613.
7. Baloch ZW, LiVolsi VA, Asa SL, et al. Diagnostic terminology and morphologic criteria for cytologic diagnosis of thyroid lesions: A synopsis of the National Cancer Institute Thyroid Fine-Needle Aspiration State of the Science Conference. Diagn Cytopathol 2008;36(6):425–437. DOI: 10.1002/dc.20830.
8. Cibas ES, Ali SZ. The 2017 Bethesda system for reporting thyroid cytopathology. Thyroid 2017;27(11):1341–1346. DOI: 10.1089/thy.2017.0500.
9. Kisansa M, Botha M, Greeff W. American College of Radiology thyroid imaging reporting and data system standardises reporting of thyroid ultrasounds. SA j radiol 2020;24(1):1–7. DOI: 10.4102/sajr.v24i1.1804.
10. Jabar ASS, Koteshwara P, Andrade J. Diagnostic reliability of the Thyroid Imaging Reporting and Data System (TI-RADS) in routine practice. Pol J Radiol 2019;84:e274–280. DOI: 10.5114/pjr.2019.86823.
11. Chng CL, Tan HC, Too CW, et al. Diagnostic performance of ATA, BTA and TIRADS sonographic patterns in the prediction of malignancy in histologically proven thyroid nodules. Singapore Med J. 2018;59(11):578–583. DOI: 10.11622/smedj.2018062.
12. Wu HH-J, Jones JN, Osman J. Fine-needle aspiration cytology of the thyroid: Ten years experience in a community teaching hospital. Diagn Cytopathol 2006;34(2):93–96. DOI: 10.1002/dc.20389.
13. Mazzaferri EL. Management of low-risk differentiated thyroid cancer. Endocr Pract 2007;13(5):498–512. DOI: 10.4158/EP.13.5.498.
14. Schenke S, Rink T, Zimny M. TIRADS for sonographic assessment of hypofunctioning and indifferent thyroid nodules. Nuklearmedizin 2015;54(3):144–150. DOI: 10.3413/Nukmed-0712-14-12.
15. Vargas-Uricoechea H, Meza-Cabrera I, Herrera-Chaparro J. Concordance between the TIRADS ultrasound criteria and the BETHESDA cytology criteria on the nontoxic thyroid nodule. Thyroid Res 2017;10(1):1–9. DOI: 10.1186/s13044-017-0037-2.
16. Haugen BR, Alexander EK, Bible KC, et al. 2015 American Thyroid Association Management Guidelines for Adult Patients with Thyroid Nodules and Differentiated Thyroid Cancer: The American Thyroid Association Guidelines Task Force on Thyroid Nodules and Differentiated Thyroid Cancer. Thyroid 2016;26(1):1–133. DOI: 10.1089/thy.2015.0020.
17. Frates MC, Benson CB, Doubilet PM, et al. Prevalence and distribution of carcinoma in patients with solitary and multiple thyroid nodules on sonography. J Clin Endocrinol Metab 2006;91(9):3411–3417. DOI: 10.1210/jc.2006-0690.
18. Keh SM, El-Shunnar SK, Palmer T, et al. Incidence of malignancy in solitary thyroid nodules. J Laryngol Otol 2015;129(7):677–681. DOI: 10.1017/S0022215115000882.
19. Dean DS, Gharib H. Epidemiology of thyroid nodules. Best Pract Res Clin Endocrinol Metab 2008;22(6):901–911. DOI: 10.1016/j.beem.2008.09.019.
20. Paschou SA, Vryonidou A, Goulis DG. Thyroid nodules: A guide to assessment, treatment and follow-up. Maturitas 2017;96:1–9. DOI: 10.1016/j.maturitas.2016.11.002.
21. Panato C, Vaccarella S, Dal Maso L, et al. Thyroid cancer incidence in India between 2006 and 2014 and impact of overdiagnosis. J Clin Endocrinol Metab 2020;105(8):2507–2514. DOI: 10.1210/clinem/dgaa192.
22. Kung AWC, Chau MT, Lao TT, et al. The effect of pregnancy on thyroid nodule formation. J Clin Endocrinol Metab 2002;87(3):1010–1014. DOI: 10.1210/jcem.87.3.8285.
23. Russ G, Bonnema SJ, Erdogan MF, et al. European Thyroid Association Guidelines for ultrasound malignancy risk stratification of thyroid nodules in adults: The EU-TIRADS. Eur Thyroid J 2017;6(5):225–237. DOI: 10.1159/000478927.
24. Chandramohan A, Khurana A, Pushpa BT, et al. Is TIRADS a practical and accurate system for use in daily clinical practice? Indian J Radiol Imaging 2016;26(1):145–152. DOI: 10.4103/0971-3026.178367.

25. Horvath E, Majlis S, Rossi R, et al. An ultrasonogram reporting system for thyroid nodules stratifying cancer risk for clinical management. J Clin Endocrinol Metab 2009;94(5):1748–1751. DOI: 10.1210/jc.2008-1724.
26. Park J-Y, Lee HJ, Jang HW, et al. A proposal for a thyroid imaging reporting and data system for ultrasound features of thyroid carcinoma. Thyroid: Off J Am Thyroid Assoc 2009;19(11):1257–1264. DOi: 10.1089/thy.2008.0021.
27. Al Dawish MA, Alwin Robert A, Thabet MA, et al. Thyroid nodule management: Thyroid-stimulating hormone, ultrasound, and cytological classification system for predicting malignancy. Cancer Inform 2018;17:1176935118765132. DOi: 10.1177/1176935118765132.
28. Srinivas MNS, Amogh VN, Gautam MS, et al. A prospective study to evaluate the reliability of thyroid imaging reporting and data system in differentiation between benign and malignant thyroid lesions. J Clin Imaging Sci 2016;6:5. DOI: 10.4103/2156-7514.177551.
29. Bongiovanni M, Spitale A, Faquin WC, et al. The Bethesda system for reporting thyroid cytopathology: A meta-analysis. Acta cytol 2012;56(4):333–339. PMID: 22846422.
30. Agarwal S, Jain D. Thyroid cytology in India: Contemporary review and meta-analysis. J Pathol Transl Med 2017;51(6):533–547. DOI: 10.4132/jptm.2017.08.04.
31. Poller DN, Bongiovanni M, Trimboli P. Risk of malignancy in the various categories of the UK Royal College of Pathologists Thy terminology for thyroid FNA cytology: A systematic review and meta-analysis. Cancer Cytopathol 2020;128(1):36–42. DOI: 10.1002/cncy.22201.
32. Inabnet WB, Palazzo F, Sosa JA, et al. Correlating the Bethesda system for reporting thyroid cytopathology with histology and extent of surgery: A Review of 21,746 patients from four endocrine surgery registries across two continents. World J Surg 2020;44(2):426–435. DOI: 10.1007/s00268-019-05258-7.
33. Chen Y-H, Partyka KL, Dougherty R, et al. The importance of risk of neoplasm as an outcome in cytologic-histologic correlation studies on thyroid fine needle aspiration. Diagn Cytopathol 2020;48(12): 1237–1243. DOI: 10.1002/dc.24557.
34. Cibas ES, Alexander EK, Benson CB, et al. Indications for thyroid FNA and pre-FNA requirements: A synopsis of the National Cancer Institute Thyroid Fine-Needle Aspiration State of the Science Conference. Diagn Cytopathol 2008;36(6):390–399. DOI: 10.1002/dc.20827.
35. Mathai AM, Preetha K, Valsala Devi S, et al. Analysis of malignant thyroid neoplasms with a striking rise of papillary microcarcinoma in an endemic goiter region. Indian J Otolaryngol Head Neck Surg 2019;71(S1):121–130. DOI: 10.1007/s12070-017-1156-8.
36. Rahal A, Falsarella PM, Rocha RD, et al. Correlation of Thyroid Imaging Reporting and Data System [TI-RADS] and fine needle aspiration: experience in 1,000 nodules. Einstein (São Paulo) 2016;14:119–123. DOI: 10.1590/S1679-45082016AO3640.