Correlation between Thyroid Imaging Reporting and Data System and Bethesda System of Reporting of Thyroid Cytopathology of Thyroid Nodule: A Single Center Experience

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Abstract

Background: The incidence of thyroid cancer has been increasing worldwide. Thyroid imaging reporting and data system (TIRADS) has been proposed for risk stratification of thyroid nodules to improve categorical management. Fine needle aspiration cytology based on Bethesda system for reporting of thyroid cytopathology (BSRTC) plays a fundamental role in the evaluation of thyroid nodule microscopically. Both the systems, the TIRADS and the latest revised BSRTC 2017, are widely recommended and practiced all over the world, but the correlation between the two systems has not been established. Aims and Objectives: This study was conducted to assess the risk of malignancy (ROM) in the intermediate Bethesda categories of thyroid lesions and their correlation with the corresponding TIRADS categories. Materials and Method: It was a prospective cross-sectional study over a year including 69 patients aged 18 years or older having solitary thyroid nodules. All cases were triaged using both TIRADS and BSRTC 2017 and the diagnostic performances were compared with subsequent paraffin sections to evaluate ROM. Correlation between TIRADS and BSRTC systems was expressed as kappa value. Result: Good concordance was observed between TIRADS and BSRTC systems in the evaluation of benign thyroid nodule lesions (category 2-II). There was discordance in follicular lesions (category 4-IV). The kappa value generated (0.411) revealed moderate agreement between the two risk stratification systems. Conclusion: Careful application of both grading systems is essential for the proper segregation of thyroid nodules to facilitate effective clinical and surgical management. However, universally acceptable protocols need to be developed to avoid the heterogeneous approach.

Keywords: Bethesda, malignancy risk, thyroid nodule

INTRODUCTION

The prevalence of thyroid nodules by palpation is 3%–8% and by ultrasound (US) is 20%–76% in general population.[1] The incidence of thyroid cancer has been increasing worldwide in the last few decades.[2] This increase is almost exclusively attributed by papillary thyroid carcinoma than other histological subtypes of thyroid carcinoma.[3,4] Introduction of highly sensitive detection method like high-resolution ultrasound is another contributor. Solitary thyroid nodule is a radiologically distinct discrete lesion with different echogenicity from surrounding thyroid parenchyma. Although US detects thyroid nodules more precisely, it differentiates benign from malignant lesion less accurately. Solid compositions, microcalcification, irregular margin, hypo-echogenicity, taller than wide shape, absent halo, and an increase in blood flow are the characteristic findings of malignancy in US. Based on the already existing breast imaging reporting and data system (BI-RADS) for breast nodule, an US-guided thyroid imaging reporting and data system (TIRADS) has been proposed for risk stratification of thyroid nodules to improve categorical management using this efficient low-cost measure.[5]

Fine needle aspiration (FNA) cytology plays a vital role in the initial diagnostic workup of solitary thyroid nodules. Evaluation of malignancy risk assigned by FNA is significant for decision making in management of solitary thyroid nodules. However, there is paucity of literature regarding correlation between TIRADS and BSRTC. This study was conducted to assess the risk of malignancy in intermediate Bethesda categories and their correlation with the corresponding TIRADS categories.

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and categorization can be improved by incorporating strategic system proposed by the latest revised Bethesda System for Reporting of Thyroid cytopathology (BSRTC-2017).[6] In spite of its intra and inter observer variability, pathologists worldwide are comfortable with this protocol. The Bethesda System classifies thyroid FNA findings into six categories with specific malignancy risks and guides in making further therapeutic decisions.

Both the systems—the TIRADS and BSRTC 2017—are widely recommended and practiced all over the world, but the correlation between the two systems has not been established. Our study is an effort to assess the correlation between the two systems.

**Materials and Methods**

**Study design**

It was a prospective cross-sectional study conducted in the Department of Pathology in collaboration with the Department of Endocrinology and Department of Radiology in our tertiary care center over 1 year. A total of 69 patients aged 18 years or above having solitary thyroid nodule detected either clinically or radiologically and having subsequently undergone surgery were included. Patients with normal thyroid scan (TIRADS-1), history of previous thyroid surgery, and confirmed case of thyroid carcinoma (TIRADS-6) were excluded from the study. Ethical committee approval was taken on 14.1.2016 [Inst/IEC/2016/35].

Determinance of sample size was done using www.openepi.com – Version 3.[7]

We calculated the sample size using the following formula:

\[
\text{Sample size } n = \left[\frac{DEFF*\text{Np} (1-p)}{(d^2/Z_{\alpha/2}^2)^*N-1} + p*(1-p)\right]
\]

Population size (for finite population correction factor or fpc) \(N\): 1000000

Hypothesized % frequency of outcome factor in the population \(p\): 8%/−5

Confidence limits as % of 100(absolute +/- %)\(d\): 5%

Design effect (for cluster surveys-DEFF): 1

Considering 90% confidence interval, 80 patients were initially incorporated in the study. But considering previously mentioned exclusion criteria, 11 patients were subsequently eliminated from study population.

Ethical committee approval was taken and informed consent was obtained from the participants of the study. A detailed analysis was performed to explore heterogeneity factors: age, sex, and nodule size.

After obtaining the signed consent, all the patients underwent US examination of the thyroid gland and FNA of the nodule was performed at the same sitting. The same radiologist read all the parameters (nodule size and shape, margins, internal content, echogenicity with presence or absence of echogenic foci) and categorized the lesion according to the TIRADS criteria by high-resolution ultrasound (PHILIPS HD7) using a 3–12 MHz broadband linear array transducer with selectable frequency and electronic focus. The FNA sample was stained with Papanicolaou and May–Grunwald–Giems (MGG) stain. Two experienced pathologists interpreted all the smears and categorized them according to Bethesda system (BSRTC-2017) [Table 1]. According to our institutional protocol, BSRTC-2017 recommendations were strictly followed for further management. As routine molecular pathology services are not available in our hospital, lobectomy was done in all cases of intermediate category for exact categorization. Tissue for final histopathology (HP) was obtained and formalin-fixed paraffin-embedded sections were examined by another pathologist for reporting according to WHO classification of tumors of endocrine organs (2017).[8]

**Statistical analysis**

The final histopathology report was considered as a gold standard and both TIRADS and Bethesda categories were compared accordingly. Risk of malignancy (ROM) was calculated as follows

\[
\text{No of cases turned out to be malignant on HP in each category} \times 100\%
\]

| No of cases in each category |

**Table 1: Thyroid imaging reporting and data system (TIRADS) and the Bethesda system for reporting cytopathology**

| **TIRADS CATEGORY** | **FEATURES** | **MALIGNANCY RISK (%)** | **BSRTC CATEGORY** | **FEATURES** | **MALIGNANCY RISK (%)** |
|----------------------|-------------|------------------------|--------------------|-------------|------------------------|
| 1                    | Normal thyroid gland | -                  | 1                  | Unsatisfactory | -                      |
| 2                    | Benign conditions  | 0                    | II                 | Benign      | 0–3                    |
| 3                    | Probably benign nodule | 5                  | III                | Atypia of undetermined significance/ Follicular lesion of undetermined significance | 5–15   |
| 4                    | Suspicious nodule  | 5%–80%               | IV                 | Suspicious of follicular lesion | 5–15   |
| 5                    | Probably malignant nodule | >80%                 | V                  | Suspicious of malignancy | 60–75  |
| 6                    | Malignant         | -                    | VI                 | Malignant   | 97–99                  |
The Kruskal–Wallis test was performed for comparisons between multiple TIRADS and BSRTC categories. The Chi-square ($\chi^2$) tests were analyzed for categorical evaluation. Correlations were evaluated using Spearman’s rank correlation. $P < 0.05$ was considered as significant. Statistical software GRAPHPAD PRISM 5–Graph Pad Software, San Diego, CA 92108 was used for analysis.

**Result**

A total of 69 patients were included in the study over a period of 1 year. Among all patients, female preponderance was seen, with male to female ratio 1:5.3 ($P$-value = 0.16). The mean age was 41.54 ± 11.86 years. A significant difference in age distribution was observed between Bethesda categories ($P = 0.0322$). It was lowest (41.82 ± 10.87) in Bethesda II and highest (48.6 ± 9.5) in Bethesda III and in between in Bethesda IV (43.23 ± 14.0) and V (44.30 ± 12.55). The mean diameter of the nodules was 3.25 ± 1.05 cm in BSRTC II, 2.38 ± 1.17 cm in BSRTC III, 3.48 ± 1.14 cm in BSRTC IV, and 5.69 ± 1.12 cm in BSRTC V. There was no striking difference in the size of the nodules in different Bethesda categories ($P$-value = 0.1012).

Of a total of 69 cases, there were 37 cases of category 2, 14 cases of category 3, 17 cases of category 4, and 1 case of category 5 according to TIRADS system. The rates of malignancies were 10.81%, 14.28%, 70.59%, and 100%, respectively. According to Bethesda system, there were 39 cases of category II, 10 cases of category III, 7 cases of category IV, and 13 cases of category V and the rates of malignancies were 5.13%, 20%, 28.57%, and 100% in categories II, III, IV, and V, respectively [Table 2 and Figure 1].

**Table 2: Malignancy risk according to the TIRAD and Bethesda system of reporting thyroid cytology (BSRTC)**

| CATEGORY | TOTAL | HISTOLOGICAL DIAGNOSIS | MALIGNANCY RISK (ROM%) |
|----------|-------|------------------------|------------------------|
| TIRADS CATEGORY | | | |
| 2 | 37 | Colloid goiter-28 | Follicular variant of Papillary thyroid carcinoma-02 | 10.81% |
| | | Adenomatoid goiter-02 | Papillary thyroid carcinoma-02 |
| | | Hashimoto thyroiditis-03 | |
| 3 | 14 | Follicular adenoma-04 | Papillary thyroid carcinoma-02 | 14.28% |
| | | Adenomatoid goiter-07 | |
| | | Hashimoto thyroiditis-01 | |
| 4 | 17 | Follicular adenoma-02 | Papillary thyroid carcinoma-09 | 70.59% |
| | | Adenomatoid goiter-03 | Lymphoma-01 |
| | | | Follicular carcinoma-01 |
| | | | Hurthle cell carcinoma-01 |
| 5 | 01 | 0 | Anaplastic carcinoma-1 | 100% |
| TOTAL | 69 | 50 | 19 | 27.14% |
| BETHESDA CATEGORY | | | |
| II | 39 | Colloid goiter-28 | Papillary thyroid carcinoma-01 | 5.13% |
| | | Adenomatoid nodule-06 | Follicular variant of Papillary thyroid carcinoma-01 |
| | | Hashimoto thyroiditis-03 | |
| III | 10 | Follicular adenoma-03 | Follicular variant of papillary thyroid carcinoma-01 | 20% |
| | | Adenomatoid goiter-05 | Papillary thyroid carcinoma-01 |
| IV | 07 | Follicular adenoma-03 | Follicular carcinoma-01 | 28.57% |
| | | Adenomatoid goiter-01 | Hurthle cell carcinoma-01 |
| | | Hashimoto thyroiditis-01 | |
| V | 13 | 0 | Papillary thyroid carcinoma-10 | 100% |
| TOTAL | 69 | 50 | 19 | 27.14% |
The highest correlation was found between TIRADS 2 and Bethesda II. The frequency of category II of Bethesda was 39/69 (56.5%) vs. TIRADS 2 37/69 (53.62%). Among 32 concordant cases of TIRADS 2 and BSRTC II, colloid goiter was the most prevailing lesion. All cases of colloid goiter \((n=28)\) were accurately categorized by both radiology and cytology. Total four cases turned out to be papillary thyroid carcinoma and were categorized as BSRTC IV/V during cytological evaluation. Almost comparable results were found while measuring malignancy risk in TIRADS 2 (10.81%) and BSRTC II (5.13%) [Figure 2].

Among the 14 cases of TIRADS 3, 6 nodules were in BSRTC III, 6 nodules in BSRTC II, and 1 case each in BSRTC IV and V, respectively. Both suspicious lesions were papillary thyroid carcinoma of classical and follicular variant on final histopathological evaluation. Cases of adenomatoid goiter were distributed in lower Bethesda category [Figure 3].

There was a striking difference in the proportion of malignancy in TIRADS category 4 and BSRTC IV. TIRADS 4 included 17 cases of suspicious nodules and papillary thyroid carcinoma (9 cases) was the commonest lesions which were classified subsequently into BSRTC V according to cytomorphological features. Other two malignant lesions showed similar categorical distribution in BSRTC IV: one case was of follicular carcinoma and the other of Hurthle cell carcinoma. Both cases revealed repetitive follicular pattern on cytology. But, the case of lymphoma was cytologically underreported as BSRTC II. All these major disparities led to the conflicting ROM between TIRADS 4 (70.59%) and Bethesda IV (28.57%) [Figure 4].

Although the number of cases was contrasting in TIRADS 5 (1 case; 1.45%) and BSRTC V (13 cases; 18.8%), both included only malignant cases which was the main concern during the evaluation of thyroid nodule. Case of anaplastic carcinoma that was reported as TIRADS 5 turned out subsequently as BSRTC V [Table 3] [Figure 5].

Moderate agreement was observed between TIRADS and Bethesda systems \((\text{kappa value} = 0.411)\). Among the benign lesions, adenomatoid nodules showed variable distribution in different TIRADS and Bethesda categories. On the other hand, papillary thyroid carcinoma was the malignant lesion which was reported as benign, intermediate, or suspicious lesion.

**DISCUSSION**

This study evaluated the correlation between TIRADS and Bethesda reporting systems for thyroid nodules. The female preponderance found in this study corroborated with previous literature \([2, 8-10]\). This was contributed mainly by Bethesda category II. Females more commonly seek medical attention and there is an increased chance of detecting thyroid nodule either by palpation or by radiology. It is considered as “medical surveillance bias.” \([11, 12]\)

After analyzing the results, our study showed a good correlation and concordance between TIRADS 2 and

**Table 3: Distribution of cases in different TIRAD and BSRTC categories**

| TIRADS  | 2  | 3  | 4  | 5  | TOTAL |
|---------|----|----|----|----|-------|
| II      | 32 | 6  | 1  | 0  | 39    |
| III     | 1  | 6  | 2  | 1  | 10    |
| IV      | 1  | 1  | 5  | 0  | 7     |
| V       | 3  | 1  | 9  | 0  | 13    |
| TOTAL   | 37 | 14 | 17 | 1  | 69    |

Kappa value-0.411 (moderate agreement)
Biswas, et al.: Correlation between TIRADS and BSRTC of thyroid nodule

BSRTC IV - A case of follicular variant of papillary thyroid carcinoma (FVPTC) showed a solid nodule in radiology; hypercellular smear with a repetitive microfollicular appearance on cytology (100 × and 400 ×, MGG stain) and follicular pattern with nuclear changes on histopathology (100 ×, H and E stain).

Figure 4: BSRTC IV - A case of follicular variant of papillary thyroid carcinoma (FVPTC) showed a solid nodule in radiology; hypercellular smear with a repetitive microfollicular appearance on cytology (100 × and 400 ×, MGG stain) and follicular pattern with nuclear changes on histopathology (100 ×, H and E stain).

BSRTC V - A case of papillary thyroid carcinoma showed hypoechoic taller than wider nodule in radiology, hypercellular smear with a large solid syncytial cluster on cytology (100 × and 400 ×, MGG stain) and papillae lined by neoplastic cells with nuclear clearing and overlapping on histopathology (100 ×, H and E stain).

Figure 5: BSRTC V - A case of papillary thyroid carcinoma showed hypoechoic taller than wider nodule in radiology, hypercellular smear with a large solid syncytial cluster on cytology (100 × and 400 ×, MGG stain) and papillae lined by neoplastic cells with nuclear clearing and overlapping on histopathology (100 ×, H and E stain).

Previously, we have analyzed the risk of neoplasm and risk of malignancies of six cytological subcategories of BSRTC III.[17] We documented that nuclear atypia with cyst macrophages was the cytological feature with highest ROM and Hurthle cell changes was the appearance with the lowest proportion of malignancy. One recent national article highlighted the differences in the management in different regions of the world and its impact on ROM.[18] Total 70.59% cases of TIRADS 4 showed a malignant lesion on final histology, whereas only 28.57% cases of Bethesda IV were found to be malignant. The original TIRADS classification also shows the ROM ranging from 5%–80% for TIRADS 4,[19] thus making this category less accurate to determine management strategies for the patient. But according to Bethesda classification 2017, malignancy risk for category IV is ranging from 15%–30% and in our study it was 28.57%. Suspicious nodules which are kept under TIRADS category 4 comprise mainly of follicular lesions of both benign (adenomatoid nodule) and malignant morphology (follicular variant of papillary thyroid carcinoma). Exact categorization of follicular lesion in FNA is difficult to interpret in majority of cases and needs surgical excision either in terms of lobectomy or near-total thyroidectomy. Similarly, during US reporting, follicular lesions appear as hypoechoic nodules. But the likelihood of malignancy gradually decreases from solid to solid-cystic to cystic lesion.[19] Among the benign lesions in intermediate categories, adenomatoid goiter was the most prevalent lesion. The radiological features of autoimmune diseases are enlargement in size of the gland along with hypervascularity and hypoechogenicity. All these US features can be encountered in diffusely infiltrative papillary or follicular thyroid carcinoma, therefore, leading to over diagnosis.[20]

The most reliable radiological features of benign lesion are the presence of circumferential uniform hallow and avascularity.[20]
Table 4: A comparative analysis with prior published studies about diagnostic performance with combination of TIRADS and BSRTC

| Study & year | Country | Design | Sample size | M:F | Mean age (years) | Concordance | Most common lesion | Conclusion |
|-------------|---------|--------|-------------|-----|------------------|-------------|-------------------|------------|
| Al-Ghanimi, et al., 2019[10] | Saudi Arabia | Retrospective | 68 cases | 78% female | 39±13 | Not mentioned | Most common malignant lesion= papillary thyroid carcinoma | Ultrasonography reliably classifies thyroid nodules, and thus can assist in decision-making regarding need for biopsy |
| Periakaruppan, et al., 2018[11] | India | Prospective | 184 cases of clinically suspected thyroid nodule over 2 years | 28:156 | Not mentioned (third to sixth decade of life) | Not mentioned | Not mentioned | Remarkable correlation exists between TIRADS ultrasound classification and Bethesda cytology, especially for benign nodules |
| Vargas-Uricoechea et al., 2017[12] | Columbia | Prospective | 180 cases of nontoxic thyroid nodule | 1:2 | 57 | Category 2-II | Not mentioned | TIRADS criteria have good correlation with Bethesda system for classification and malignancy |
| Yoon et al., 2015[13] | Korea | Retrospective | 763 cases over 5 years | Not mentioned | 52.3 years 6 11.5 | All except unsatisfactory group | Not mentioned | Near-perfect correlation was seen between the TIRADS category and malignancy risk in the post-Bethesda period |
| Present study | India | Prospective | 69 cases of solitary thyroid nodule over 1 year | 1:5.3 | 41.54±11.86 | Category 2-II | Benign lesion=colloid goiter; malignant lesion=papillary thyroid carcinoma | Critical appraisal of both grading systems is essential in proper segregation of thyroid nodules for effective clinical and surgical management. |

But a significant proportion of papillary thyroid carcinoma reveals similar features resulting in faulty categorization. Srinivas et al. conducted a prospective study and concluded that five independent sonological features are significantly related to malignant cytology: Solid composition, marked hypoechogenicity, irregular margins, microcalcifications, and taller than wide shape. Among these features, irregular margins were the most sensitive for malignancy followed by taller than wide shape, microcalcification, marked hypoechogenicity, and solid composition in this order. In our study, we found that variable combination of these features was helpful in the differentiation of benign from malignant nodules rather than any individual US appearance. According to another literature, microcalcification is the most reliable predictor of malignancy. But, we found microcalcification in one case of follicular adenoma. Taki et al. reported a similar finding in the past. In our study, papillary thyroid carcinoma revealed variable radiological features. It was postulated that US appearance changes according to histological subtype. Follicular variant is reported as a benign lesion in most of the instances.

According to American Thyroid Association (ATA) guideline, TIRADS followed by FNA examination of thyroid nodule shows better reproducibility in terms of advocating more invasive procedures. One previous study showed that depending on the presence of different US patterns along with FNA study categorizing an individual as low risk, intermediate risk, and high risk enables optimal clinical decision making regarding management strategies. Limitation of our study: Our prospective study was conducted including 69 cases only and, therefore, larger series with follow-up data would be useful for substantiation. In conclusion, there is a good concordance between US report using TIRAD criteria and FNA using Bethesda to evaluate thyroid nodule in benign lesion (2-II). There is discordance in suspicious nodules (4-IV). For accurate diagnosis and institution of more preserving surgery, a combination of TIRADS and BETHESDA is needed simultaneously. Both systems are complementary to each other. However, more extensive studies and standardized management protocols need to be developed to prevent heterogeneous approach.
Declaration of patient consent
The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest
There are no conflicts of interest.

REFERENCES
1. Gharib H, Papini E, Paschke R, Duick DS, Valvevi R, Hegeduš L, et al. American Association of clinical endocrinologists, assoziazione medici endocrinologi, and European thyroid association medical guidelines for clinical practice for the diagnosis and management of thyroid nodules. Endocr Pract 2010;16:468–75.
2. Vargas-Uricoechea H, Meza-Cabrera M, Herrera-Chaprro J. Concordance between the TIRADS ultrasound criteria and the BETHESDA cytology criteria on the nontoxic thyroid nodule. Thyroid Res 2017;10:1.
3. Ferlay J, Soejoamtaram I, Dikshit R, Eser S, Mathers C, Rebelo M, et al. Cancer incidence and mortality worldwide: Sources, methods and major patterns in GLOBOCAN 2012. Int J Cancer 2015;136:359–86.
4. Torre LA, Bray F, Siegel RL, Ferlay J, Lortet-Tieulent J, Jemal A. Global cancer statistics, 2012. CA Cancer J Clin 2015;65:87–108.
5. Tessler FN, Middleton WD, Grant EG, Hoang JK, Berland LL, Teeffey SA, et al. ACR thyroid imaging, reporting and data system (TI-RADS): White paper of the ACR TI-RADS committee. J Am Coll Radiol 2017;14:587–95.
6. Cibas ES, Ali SZ. The 2017 Bethesda system for reporting thyroid cytopathology. Thyroid 2017;27:1341–6.
7. Sullivan KM, Dean A, Soe MM. OpenEpi: A web-based epidemiologic and statistical calculator for public health. Public Health Rep 2009;124:471–4.
8. Lloyd RV, Osamura RY, Kiöppel G, Rosai J, editors. WHO Classification of Tumours of Endocrine Organs. 4th ed. Lyon, France: IARC; 2017.
9. Yoon JH, Lee HS, Kim EK, Moon HJ, Kwak JY. Thyroid nodules: Nondiagnostic cytologic results according to thyroid imaging reporting and data system before and after application of the Bethesda system. Radiology 2015;276:759–87.
10. Al-Ghanimi IA, Al-Shayyadh AM, Al-Mulhim S, Faisal S, Al-Abdulwahab A, Al-Aftan M, et al. Diagnostic accuracy of ultrasonography in classifying thyroid nodules compared with fine-needle aspiration. Saudi J Med Med Sci 2019;8:25-31.

11. Haut ER, Promovost PJ. Surveillance bias in outcomes reporting. JAMA 2011;305:2462–3.
12. Hoppin JA, Tolbert PE, Taylor JA, Schroeder JC, Holly EA. Potential for selection bias with tumor tissue retrieval in molecular epidemiology studies. Ann Epidemiol 2002;12:1-6.
13. Periakaruppan G, Sheshadri KG, Vignesh Krishna GM, Mandava R, Sai VPM, Rajendiran S. Correlation between ultrasound-based TIRADS and Bethesda System for reporting thyroid-cytopathology: 2-year experience at a tertiary care center in India. Indian J Endocrinol Metab 2018;22:651–5.
14. Brito JP, Gionfriddo MR, Al Nofal A, Boehmer KR, Leppin AL, Reading C, et al. The accuracy of thyroid nodule ultrasound to predict thyroid cancer: Systematic review and meta-analysis. J Clin Endocrinol Metab 2014;99:1253–63.
15. Rosario PW. Thyroid nodules with atypia or follicular lesions of undetermined significance (Bethesda category iii): Importance of ultrasonography and cytological subcategory. Thyroid 2014;24:1115–20.
16. Haugen BR, Alexander EK, Bible KC, Doherty GM, Mandel SJ, Nikiforov YE, 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;26:1–133.
17. Maity P, Jha AK, Sengupta M, Basu K, Chatterjee U, Ghosh S. Thyroid bethesda atypia of undetermined significance or follicular lesion of undetermined significance (AUS/FLUS): A heterogenous group. J Cytol 2019;36:200–4.
18. Guleria P, Mani K, Agarwal S. Indian experience of AUS/FLUS diagnosis: Is it different from rest of Asia and the West?—A systematic review and meta-analysis. Gland Surg 2020. doi: 10.21037/gs-20-392.
19. Xie C, Cox P, Taylor N, LaPorte S. Ultrasonography of thyroid nodules: A pictorial review. Insights Imaging 2016;7:77–86.
20. Hoang JK, Lee WK, Lee M, Johnson D, Farrell S. US features of thyroid malignancy: Pearls and pitfalls. Radiographics 2007;27:847–65.
21. Chan BK, Desser TS, McDougall IR, Weigel RJ, Jeffrey RB Jr. Common and uncommon sono graphic features of papillary thyroid carcinoma. J Ultrasound Med 2003;22:1083–90.
22. Srinivas MN, Amogh VN, Gautam MS, Prathyusha IS, Vikram NR, Retnam MK, 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.
23. Taki S, Terahata S, Yamashita K, Kinuya K, Nobata K, Kakuda K, et al. Thyroid calcifications: Sonographic patterns and incidence of cancer. J Ultrasound Med 2019;38:2370–7.
24. Baek HJ, Kim DW, Shin GW, Heo YJ, Baek JW, Lee YJ, et al. Ultrasonographic features of papillary thyroid carcinomas according to their subtypes. Front Endocrinol 2018;9:223.
25. Adamczewski Z, Lewiński A. Proposed algorithm for management of patients with thyroid nodules/local lesions, based on ultrasound (US) and fine-needle aspiration biopsy (FNAB); own experience. Thyroid Res 2013;6:6.