CORRELATION OF AMERICAN COLLEGE OF RADIOLOGY (ACR)-THYROID IMAGING REPORTING AND DATA SYSTEM (TIRADS) FINDINGS IN ULTRASONOGRAM (USG) OF THYROID NODULES WITH FNAC OR BIOPSY FINDINGS

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ABSTRACT

Thyroid Imaging Reporting and Data System (TIRADS) classifies the different ultrasound patterns of thyroid nodule into different TIRADS classes based on their malignant potential. And ultrasound-guided fine needle aspiration cytology (FNAC) is considered the most accurate method to evaluate thyroid malignancy. A prospective study was carried out during 2020 - 2021 in the Department of Radiology & Imaging of Nepal Medical College and Teaching Hospital, Attarkhel, Jorpati, Kathmandu, Nepal, in which a total of 115 patients underwent ultrasonography of the lesions in one or both lobes or isthmus of the thyroid gland. The patients underwent FNAC or biopsy for these thyroid lesions. This study was carried out to correlate ACR-TIRADS findings in USG of thyroid nodules with FNAC or Biopsy findings. The ages of the patients ranged between 13 years to 77 years, with 72 female patients and 43 male patients. Different varieties of USG features were found in all the different categories of the ACR-TIRADS scoring system. Of total 115 nodules, maximum cases were in TR 3 (33.0%), followed by TR 2 (28.7%), TR 4 (18.3%), TR 1 (13.9%) and TR 5 (6.1%). Cytopathological reports revealed 75.6% of cases to be non-neoplastic. Among neoplastic lesions, 14 (12.2%) were of the indeterminate type of lesions and 14 (12.2%) were malignant nodules. Colloid goiter constituted the majority of non-neoplastic thyroid nodules (39.9%) and papillary carcinoma constituted 8.6% of the cases. The risk of malignancy was 0% for TR 1 and TR2 nodules, 7.9% for TR 3 nodules, 23.9% for TR 4 nodules, and 85.7% for TR 5 nodules. TIRADS score and cytopathological findings correlated well for TR 1, TR 2, and TR 5 lesions but showed less agreement for TR 3 and TR 4 nodules. This might be because of the overlap of USG characteristics between benign and malignant thyroid nodules.

KEYWORDS

ACR-TIRADS, biopsy, FNAC, nodule, thyroid gland, ultrasonography

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INTRODUCTION

Thyroid nodules are very prevalent and they are found in approximately 4-8% of adults by clinical palpation whereas, by imaging modalities as high-resolution ultrasonography, the prevalence rate becomes high ranging from 20 to 76%.[1] The majority of nodules are asymptomatic and are benign but when discovered incidentally or clinically needs workup and further investigations.[2] Thyroid nodules are 16 times more common in females due to the high prevalence of endocrine disorders.[3] Benign thyroid lesions are more common than malignant ones and the incidence of malignancy in thyroid nodules is 5-10%.[4] Contrary to thyroid nodules, thyroid cancer is quite rare and the incidence is 8.7 per 100,000 people per year, though this seems to be increasing over the years.[5] In recent years, FNAC has been the greatest achievement in assessing thyroid nodules with a sensitivity of FNAC over 90% and specificity of 75%.[6] Though FNAC remains pivotal for the assessment of thyroid nodules, it is mildly distressing, leads to additional healthcare costs, and contains a low risk of infection and bruising.[7]

Ultrasound (USG) is also a choice of investigation of thyroid nodule and has the advantage of being noninvasive and inexpensive.[8] TIRADS was first introduced in 2009 by Hovard *et al*. This data classifies the different ultrasound patterns of thyroid nodule into different TIRADS classes based on their malignant potential.[9] Since then several classification systems have been proposed like modified TIRADS (2011), British U-system (2014), and ATA guidelines but the classification system by the American College of Radiology called ACR-TIRADS has been widely used since its introduction in 2017.[10] The ACR-TIRADS scoring system is shown below in Table 1.

Thyroid nodules (TNs) may show highly diverse ultrasound patterns. Some USG features described as suspicious for malignancy includes hypoechogenicity, microcalcifications, partially cystic nodule with the eccentric location of the fluid portion and lobulation of the solid component, irregular margins, perinodular thyroid parenchyma invasion, taller-than-wide shape, and intranodular vascularity.[11]

Ultrasound-guided FNAC is considered the most accurate method to evaluate thyroid malignancy. But due to the high frequency of benign thyroid nodules and the invasive nature of the technique, biopsy is not feasible in all cases. Hence, ultrasound plays an important role in characterizing benign and malignant thyroid nodules and avoids unnecessary invasive procedures in benign thyroid nodules. This study is being carried out to correlate the TIRADS findings and TIRADS score in USG of thyroid nodule with FNAC or Biopsy findings in predicting the risk of malignancy.

MATERIALS AND METHODS

A cross-sectional comparative study was carried out in the Department of Radiology and Imaging, Nepal Medical College Teaching Hospital, Attarkhel, Gokarneshwor-8, Kathmandu, Nepal during October 2020 and September 2021. Sample size was calculuated using the formula $n=z^2p\ (100-p)d^2$, with expected prevalence of thyroid nodules of 8% and with margin of error 5%. A total of 115 patients underwent conventional high-resolution ultrasound using a 7.5MHz Linear array transducer, Toshiba Xario USG unit and all thyroid nodules were assessed for the five features categories in the ACR-TIRADS lexicon i.e. composition, echogenicity, shape, margin, and echogenic foci. A score was given for features noted in each category according to the ACR-TIRADS scoring system. (Table 1). The total score was then calculated by adding all the points and the thyroid nodule was classified as TIRADS 1 to TIRADS 5 based on the total score obtained i.e. TR 1 = 0 point, TR 2 = 2, points, TR 3 = 3 points, TR 4 = 4-6 points and TR 5 = 7 points and above. All the patients were scanned in one session only. USG guided FNAC or Biopsy was done in the next sitting when the patient came back, with referrals by the clinician for FNAC or biopsy. There was no further need to follow up the patient, thereafter, for this study.

All cases of thyroid nodules diagnosed clinically and radiologically were identified in the Department of Radiology. A thorough history of the patient was taken and a clinical examination of the thyroid nodule was done. Patients' particulars and size and location of thyroid nodule were noted and were entered in the preformed proforma.

The patients were then counseled for the need of FNAC or biopsy of thyroid nodule and informed consent was taken for the same. All the patients undergoing both USG and FNAC of thyroid nodule were enrolled for the study. The patients not giving consent for FNAC were not included in the study. Patients not undergoing FNAC and directly going for surgery were also included in the study.

FNAC was done in either Department of Radiology and Imaging or the Department of

Pathology by a 22 gauge needle attached to a 10 ml syringe by aspiration technique and cytology smear was prepared for analysis. The FNAC or Histopathological Examination (HPE) findings were traced and were followed up from the Pathology Department. TIRADS findings and scores were correlated with FNAC findings using appropriate statistical methods.

RESULTS

A total of 115 patients underwent ultrasonography for thyroid nodules during the study period. And they subsequently went for either FNAC or biopsy. The ages of the patients ranged between 12 and 77 years (mean age being 48.9 ± 14.2 years), 72 (62%) being female and 43 (38%) being male patients (F: M ratio = 1.67:1). 34 (29.6%) patients were in the age group of 41-50 years followed by 24 (20.9%) in 51=60 years. There were 4 (3.5%) between 11 to 20 years and 9 (7.8%) between 21-30 years. Only 8 (6.9%) were above the age of 71 (Table 1). Out of 115 nodules, 66 cases (57.4%) were from the right lobe, 41 (35.7%) from the left lobe, and 8 (6.9%) from the isthmus of the thyroid gland.

Table 1: Distribution of age

Age Group (years)	N	%
11-20	4	3.5
21-30	9	7.8
31-40	15	13.0
41-50	34	29.6
51-60	24	20.9
61-70	21	18.3
Above 71	8	6.9
Total	**115**	**100**

Regarding the different ultrasonographic morphological characteristics of thyroid nodules based on the ACR-TIRADS, 46 (40%) were solid followed by 31 (27%) being mixed solid cystic, 22 (19.1%) being cystic, and 16 (13.9%) spongiform. 31 (27%) nodules were hyperechoic, 28 (24.5%) isoechoic, 25 (21.7%) hypoechoic, 22 (19.1%) anechoic and 9 (7.8%) were markedly hypoechoic. One hundred and four cases (90.4%) nodules were wider than tall and only 11 (9.6%) were taller than wide. 87 (75.6%) cases had a smooth margin, 15 (13.0%) had an ill-defined margin, 9 (7.8%) had irregular or lobulated outline and only 4 (3.6%) had an

Table 2: ACR-TIRADS Scoring system

Characteristics	Score	n	%
Composition			
Cystic	0	22	19.1
Spongiform	0	16	13.9
Mixed solid-cystic	1	31	27.0
Solid	2	46	40.0
Echogenecity			
Anechoic	0	22	19.1
Hyperechoic	1	31	27.0
Isoechoic	1	28	24.3
Hypoechoic	2	25	21.7
Markedly hypoechoic	3	9	7.8
Shape			
Wider than tall	0	104	90.4
Taller than wide	3	11	9.6
Margin			
Smooth	0	87	75.6
Ill-defined	0	15	13.0
Lobulated / Irregular	2	9	7.8
Extrathyroid extension	3	4	3.6
Echogenic foci			
None	0	77	66.9
Large Comet Tail artifacts	0	18	15.7
Macrocalcification	1	11	9.6
Rim calcification	2	3	2.6
Punctate Echogenic Foci	3	6	5.2

Table 3: Distribution of thyroid nodules according to ACR-TIRADS Scoring system

ACR TIRADS category	Total Score	n	%
ACR-TIRADS 1 (TR1) (benign)	0	16	13.9
ACR-TIRADS 2 (TR2) (not suspicious)	2	33	28.7
ACR-TIRADS 3 (TR3) (mildly suspicious)	3	38	33.0
ACR-TIRADS 4 (TR4) (moderately suspicious)	4-6	21	18.3
ACR-TIRADS 5 (TR5) (highly suspicious)	7+	7	6.1
Total		**115**	**100**

extrathyroid extension. 77 (66.9%) cases had no calcifications, 18 (15.7%) had large comet tail artifacts, 11 (9.6%) had macrocalcifications. 6 (5.2%) had punctuate echogenic foci and only 3 (2.6%) had rim calcifications (Table 2).

Of 115 cases of thyroid nodules, maximum of 38 cases (33%) of the nodules were of TR 3, followed by 33 cases (28.7%) being TR 2. There were 21 cases (18.3%) in TR 4, 16 (13.9%) in TR 1, and only 7 (6.1%) in TR 5 category (Table 3).

Of total 115 cases included in the study, FNAC was performed in 106 cases and biopsy was done in 9 cases. FNAC and biopsy reports showed more cases of non-neoplastic thyroid nodules than the neoplastic ones: 87 cases (75.6%) being non-neoplastic and the remaining 28 cases (24.4%) being neoplastic. 39 cases (39.9 %) of colloid goiter constituted the majority of the non-neoplastic thyroid nodules. Lymphocytic thyroiditis (16 cases, 13.9%), Hashimoto's thyroiditis (12 cases, 10.4%), hyperplastic thyroid nodule (10 cases, 8.6%), granulomatous thyroiditis (5 cases, 4.3%), and de Quervain's thyroiditis (5 cases, 4.3%) were other non-neoplastic lesions found in the cytopathological findings.

Among 28 cases of neoplastic lesions, 8 cases (16.9%) were reported as follicular neoplasm in FNAC, which could either be benign or malignant. There were 6 cases (5.2%) that were suspicious of malignancy. And there were 14 cases (12.2%) of malignant thyroid nodules. Remaining 14 cases (12.2%) were malignant nodules. Among these 14 cases of malignant thyroid nodules, 8 (8.6 %) cases were papillary carcinoma, 2 (1.7%) were anaplastic carcinoma, 2 (1.7%) were metastasis, 1 (0.9%) was lymphoma and 1 (0.9%) was medullary carcinoma (Table 4).

Table 4: Cytopathological diagnosis of thyroid nodules

Cytopathological diagnosis/ HPE	Benign	Indeterminate	Malignant	Total	
				n	%
Colloid goiter	39			39	33.9
Lymphocytic thyroiditis	16			16	13.9
Hashimoto's thyroiditis	12			12	10.4
Hyperplastic thyroid nodule	10			10	8.6
Granulomatous thyroidits	5			5	4.3
de Quervain's thyroiditis	5			5	4.3
Follicular neoplasm		8		8	6.9
Suspicious of malignancy		6		6	5.2
Papillary carcinoma			8	8	8.6
Anaplastic carcinoma			2	2	1.7
Metastasis			2	2	1.7
Medullary carcinoma			1	1	0.9
Lymphoma			1	1	0.9
Total	**87**	**14**	**14**	**115**	**100**

Table 5: Comparison of ACR – TIRADS with the cytopathological diagnosis

TIRADS score	Benign	Indeterminate	Malignant	Total
TR 1	16 (100%)			16 (100%)
TR 2	30 (90.9%)	3 (9.1%)		33 (100%)
TR 3	29 (76.3%)	6 (15.8%)	3 (7.9%)	38 (100%)
TR 4	12 (57.1%)	4 (19.0%)	5 (23.9%)	21 (100%)
TR 5		1 (14.3%)	6 (85.7%)	7 (100%)
Total	**87 (75.6%)**	**14 (12.2%)**	**14 (12.2%)**	**115 (100%)**

The comparative study between ACR-TIRADS score and cytopathological findings was done in all 115 cases which is shown in the table below (Table 5).

All 16 cases of TR 1 nodules (benign) came out to be benign in the cytopathological study. Out of the total of 33 cases, 30 cases (90.9%) of TR 2 nodules (not suspicious), turned out to be benign and 3 cases (9.1%) came out to be of indeterminate type. Out of 38 cases of TR 3 (mildly suspicious) nodules, 29 (76.3%) were benign, 6 (15.8%) were indeterminate and 3 (7.9%) were malignant. Similarly, out of 21 cases of TR 4 (moderately suspicious lesions), 12 (57.1%) were benign, 4 (19%) indeterminate and 5 (23.9%) were malignant. In TR 5 (highly suspicious) nodules, out of 7 cases, 6 cases (85.7%) were malignant and only 1 case (14.3%) was of indeterminate pathology.

DISCUSSION

Thyroid nodule is a very common condition in Nepal. With the increased use of high-resolution ultrasound during the last two decades, thyroid nodule detection has increased.[12] Thyroid enlargement leads to a series of investigations to rule out any possibility of malignancy. FNAC is the first choice of investigation and when combined with USG, also called USG guided FNAC, results in better diagnosis in cases of an impalpable thyroid nodule.[13]

In this study, the age range of patients was 12 to 77 years and the mean age of presentation was 48.9 years, at 95% confidence level. In a study done by Regmi *et al*, the mean age presenting with a thyroid nodule is similar or close to the study findings.[14] In a study done by Devkota *et al*, the mean age of presentation was 41.42 years which was slightly lower than this study.[3]

In this present study, the most common age group presenting with thyroid nodule was 41 to 50 years (29.6%) followed by 51-60 years (20.9%). A study conducted by Devkota *et al*[3], showed the most common age group as 31-40 years, which is in the lower age group as compared to this study. Studies done by Bhuyar *et al*[15], Abdelkader *et al*[16] and Kirdak *et al*[17] also showed a maximum number of patients presenting with thyroid nodules in the lower age group.

There were more females in this study where the F: M ratio was 1.67:1. Similarly, a study conducted by Regmi *et al* showed that out of 54 cases, 50 cases (92.6%) were female and 4 cases (7.4%) were male with M: F ratio of 1:12.5.[14] Chaudhary *et al*, also showed a female predominance giving male to female ratio of 1:19.3.[18] Bhatta *et al*, in a study of 90 patients with thyroid nodule showed that 72 (80 %) were female and 18 (20%) were male with M: F ratio of 1:4.[19] Devkota *et al* also showed similar findings in their study.[3] Finally, the interpretation of the result in this study infers that almost two-thirds of the subjects were women probably because autoimmune thyroid disease is significantly more frequent in females than in males.

The most common site presenting with thyroid nodule in this study was the right side (57.4%) followed by the left side (35.7%) and isthmus (6.9%). A similar study done in Nepal by Regmi *et al*[14], showed that the common site presenting with thyroid nodule was right (40.70%) followed by bilateral involvement (31.50%). A study conducted in Egypt by Abdelkader *et al* depicted similar findings with 40% involvement of right side followed by 32% involvement of left side.[16]

In a study done by Vera *et al*,[20] the thyroid nodules were predominantly solid (60% cases) followed by mixed (31% cases) and cystic patterns (2% cases). In this study also, similar findings were found. Nodules were solid in 40% and followed by mixed solid-cystic in 27% and cystic in 19%. Other TIRADS based ultrasonographic findings regarding echogenicity, shape, margin and echogenic foci also were similar to the findings in the studies done by Abdelkader *et al*[16] and Periakaruppan *et al*.[21]

In a study conducted by Regmi *et al*[14] and Periakaruppan *et al*[21], the maximum number of thyroid nodules undergoing USG were benign thyroid nodules reported as TIRADS 2 which was 85.2% and 63.58 % respectively. The incidence of thyroid nodules which were reported in the TR 2 category was only 28.7% in this study which is quite less as compared to other studies. This is because TR1 was not included in those studies. In this study, TR1 nodules constituted 13.9% of the nodules.

In this present study, the most common thyroid nodule undergoing FNAC was colloid goiter with or without cystic changes (33.9%) followed by lymphocytic thyroiditis (13.9%). A study done by Choudhary *et al* showed a similar finding where the highest percentage of thyroid nodule undergoing FNAC was colloid goiter (59.4%) followed by lymphocytic thyroiditis (12%).[18] Similar finding was seen in Nepal done by Karki *et al*.[22]

In a study conducted by Mohanty *et al* in the year 2018, 50 thyroid nodules were evaluated by USG according to ACR-TIRADS and based upon score received, categorized in 5 groups i.e. TIRADS 1 to TIRADS 5 and this was correlated

with FNAC/ HPE reports. They reported that among ACR-TIRADS categories, TR1, TR2, and TR3 had 0% risk while TR 4 had 30% and TR5 had 56% risk of malignancy thus stating that the higher the TIRADS score, the higher the risk of malignancy.[23]

In another study performed by Jabar *et al* in the year 2018, 127 thyroid nodules were evaluated using ACR-TIRADS criteria and compared it to the final diagnosis obtained by cytological / histopathological analysis. They reported that the risk of malignancy was 0% in ACR-TR1 and ACR-TR2, 6.9% in ACR-TR 3, 29.3% in ACR-TR4, and 80% in TR5 categories respectively stating that TIRADS classification is a reliable, non-invasive and practical method for assessing thyroid nodules.[24]

In the year 2019, Azab *et al* assessed 40 thyroid nodules based on ACR-TIRADS criteria and compared it with FNAC and HPE reports and reported that there was a statistically significant higher risk of malignancy as the final TIRADS level increased from TR-1 to TR-5 (p-value < 0.001).[25]

This study evaluated the concordance between the TIRADS and the cytopathological findings of thyroid nodules. The result showed agreement on the benign conditions of thyroid nodule and the most frequent correlation was found for the TR1 category followed by TR2 nodules. In a study conducted by Hernando *et al*, a similar finding was seen. The USG findings of the benign lesion were aligned with the cytology results which showed the highest concordance with the Bethesda-II and TIRADS 2 categories.[26]

On the other end, TR5 nodules also correlated well with the cytopathological findings. Most of the TR3 and TR4 nodules still turned out to be benign in cytopathological findings. This might be because of the wide overlap of USG characteristics between benign and malignant thyroid nodules. This might also be because of the indeterminate group of cytopathological findings which constitute 12.2% of the total cases, which might be either of benign or of malignant nature.

Regmi *et al* showed a substantial agreement between the diagnosis made by these systems and observed 77.7% agreement in diagnosis between TIRADS and TBSRTC.[14] Study of Singaporewalla *et al*, suggested an agreement of 83% between these two reporting systems of thyroid lesion.[27]

In this study, the prevalence of malignancy was 0% for persons with TR 1 and TR2 nodules, 7.9% for TR 3 nodules, 23.9% for TR 4 nodules, and 85.7% for TR 5 nodules. This corroborated with similar studies done in the past, in different parts of the world.[23,24,25,26,27]

In conclusion, ACR-TIRADS which is based on different sonographic morphological characteristics of thyroid nodules, could be used as a screening tool in differentiation of benign and malignant thyroid nodules. However, FNAC or biopsy is recommended for the final diagnosis in thyroid nodules with TR 3 and above, as there is more risk of malignancy with higher TIRADS grade.

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