A Study of Evaluation of Thyroid Pathologies on Ultrasound and Color Doppler with Histopathological Correlation

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ABSTRACT

Introduction: Thyroid lesions are a frequent occurrence region where iodine deficiency is a problem, like in India. Ultrasonography is extremely beneficial for early management and complication prevention. Colour doppler examinations can provide dynamic information such as blood flow velocity and direction as well as the degree of an organ's vascularity.

Material and methods: A prospective, observational study conpatients of any age/gender, who were diagnosed having thyroid pathologies primarily on ultrasonography and color doppler. We excluded patients, who were not giving consent for participation and not undergone histopathological examination.

Results: Out of 54 patients, the majority (85.04 %) of these patients were female patients and a higher percentage (66.67 %) patients were from age group of 21 to 40 years. Majority of benign thyroid pathology had Cystic (55.55 %), anechoic (44.44 %), smooth/ill-defined margins (74.07 %), and large comet tail artifacts (62.96 %). Majority of malignant thyroid pathology have solid in composition (7.41 %), very hypoechoic (7.41 %), lobulated/irregular margins (7.41 %), and punctate echogenic foci/peripheral calcification (7.41 %/5.55 %). categories TR2 and TR4 demonstrating, higher accuracy of our radiological finding of thyroid pathology (P value<0.05).

Conclusion: ACR-TIRADS is appropriate classification system to evaluate to identify and subclassify thyroid pathology, which is helpful to avoid expensive and painful procedures. The lesion, which on ultrasonography and color doppler study appear solid/solid cystic, very hypoechoic, taller than wider, with irregular margins, punctate echogenic foci or peripheral calcification and internal ± peripheral color flow should be suspected for malignant lesion. And should undergo histopathological examination.

Keywords: ACR-TIRADS, Benign Thyroid Pathology, Color Doppler, Malignant Thyroid Pathology, Ultrasonography

INTRODUCTION

Thyroid lesions are a frequent occurrence in the general population, particularly in regions where iodine deficiency is a problem, like in Indian population. Thyroid disorders like thyroid neoplasm continue to be a serious issue in both developing and developed countries.[1] One of the most prevalent endocrine and surgical problems in clinical practice is thyroid disorders. With the exception of some areas of India that are endemic for iodine deficient illnesses, the profile of thyroid problems seen in children and adolescents in this country is similar to that seen in most other parts of the world.[2] About 3% to 8% of the population seems to have thyroid nodules, and beyond age 65, their prevalence rises to more than 50%.[3]

In 1966–1967, thyroid sonography was first developed. Sonography is now the most widely used imaging tool that can reveal anatomical details and pathological conditions relating to the thyroid gland for clinical application. This is extremely beneficial for early management and complication prevention. Thyroid vascular studies are conducted using colour Doppler sonography. Colour doppler examinations can provide dynamic information such as blood flow velocity and direction as well as the degree of an organ's vascularity. Vascular ultrasound imaging is a low-cost, non-invasive technique.

The solitary thyroid nodule is common presentation and the incidence of carcinoma in single thyroid nodule is between 8-20% and in multinodular goitre is about 5%. This concern is warranted as the most neoplasm originate in a focus of replicating cells and present as solitary thyroid nodule in early stage of malignancy.[4]

Differentiation between nonneoplastic and neoplastic thyroid disease is not difficult. Accurate subtyping and grading of thyroid neoplasms are possible only with the combined efforts of sonologists and pathologists. With its increasing use, it is evident that USG is becoming more and more reliable as a predictor of the exact nature of thyroid lesions.[5,6,7] The purpose of my study is to evaluate Ultrasonography and color Doppler finding in different thyroid diseases and correlate with histopathological finding and increase accuracy of provided diagnosis.

MATERIAL AND METHODS

A prospective, observational study was initiated after getting approval from Institutional Review Board (IRB). Prior to study consent was taken from each patient or patients' relatives. Identity of patients were remained confidential. We had included patients of any age/gender,

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who were diagnosed having thyroid pathologies primarily on ultrasonography and color doppler at radiology department of L.G. General Hospital. Also, same patients, who undergone histopathological examination (Biopsy/FNAC) for confirmation of diagnosis. We excluded patients, who were not giving consent for participation and not undergone histopathological examination. Study was conducted over a period of March, 2022 to August, 2022. The collected data was entered in Microsoft excel sheets and appropriate statistical test were used for data analysis.

USG imaging and imaging analysis

On a AFFINITI 70 G Phillips Ultrasound machine, the thyroid gland and neck were all scanned using L12-5 linear probe with an optimum gain. The internal component (solid, mixed, or cystic), margins, echogenicity, presence of calcifications, and shape were used to categories all thyroid pathology. Margin types were well circumscribed, lobulated, and irregular. The terms "hyperechogenicity," "isoechogenicity," "hypoechogenicity," and "marked hypoechogenicity" were used to categories echogenicity. The term "isoechogenicity" refers to echogenicity that is comparable to that of the thyroid gland next to it in healthy thyroid gland. If the echogenicity of a nodule was lower than that of the superficial surrounding neck muscles, it was categorized as having "marked hypoechogenicity." When present, calcifications were classified into macrocalcifications (more than 3 mm with acoustic shadowing) and microcalcifications (less than 3 mm). The nodule's shape was classified as "wider than tall" or "taller than wide". Each nodule was allocated a TIRADS category (1 to 5) based on the US characteristics using the American College of Radiology's thyroid imaging reporting and data system (ACR-TIRADS) classification. Table 1 and Fig. 1 illustrate the ACR-TIRADS classification.[8]

TIRADS level	Sum of points	Classification
TR1	0	Benign nodule
TR2	2	Not suspicious
TR3	3	Mildly suspicious
TR4	4-6	Moderately suspicious
TR5	7 or >7	Highly suspicious

Table-1: Thyroid imaging, reporting and data system: scoring and classification

RESULT

Table 2 showed that a total of 54 patients was diagnosed with thyroid pathology, the majority (85.04%) of these patients were female patients, whereas just 7 (12.96%) male patients were reported in our study. Higher (75.92%) percentage of female patients were found to be suffering from benign thyroid pathology. The age group of patients from 21 to 40 years was represented by the highest percentage (66.67%), followed by the age group of patients from 41 to 60 years with 14 patients (25.92%) out of 54 patients. No male patient was found be suffering from thyroid pathology below 20-year age. In malignant thyroid pathology, 6 (11.12%) females were found to be affected in our study. In which, majority (4, 7.41%) of patients were from 41 to 60 years, followed by equal number of patients in the age group of 21 to 40 years (1, 1.85%) and more than 60 years (1, 1.85%).

According to Table – 3, 50 (92.59%) patients were found to suffering from benign thyroid pathology on USG finding. Whereas, histological finding showed 48 (88.89%) patients had benign thyroid pathology. Similarly, malignant thyroid pathology was found in 4 (7.41%) patients in radiological finding. In histopathological finding, 6 (11.12%) patients were found to be suffering from malignant thyroid pathology. Mismatch between radiological and histological findings were found in 2 patients, where radiologically suspected benign lesions diagnosed as malignant lesions.

Table – 4 shows, evaluation of benign and malignant lesions of thyroid on USG according to TIRADS classification. Majority of benign thyroid pathology had Cystic (55.55%), anechoic (44.44%), smooth/ill-defined margins (74.07%), and large comet tail artifacts (62.96%). Majority of malignant thyroid pathology have solid in composition (7.41%), very hypoechoic (7.41%), lobulated/irregular margins (7.41%), and punctate echogenic foci/peripheral calcification

Variable		Type of Thyroid Pathology		Total n (%)
		Benign n (%)	Malignant n (%)	
Gender	Female	41 (75.92)	6 (11.12)	47 (85.04)
	Male	7 (12.96)	0	7 (12.96)
Age (Years)	< 20	2 (3.70)	0	2 (3.70)
	21-40	35 (64.81)	1 (1.85)	36 (66.67)
	41-60	10 (18.52)	4 (7.41)	14 (25.92)
	> 60	1 (1.85)	1 (1.85)	2 (3.70)
Total		48 (88.89)	6 (11.12)	54 (100)

Table-2: Demographic details of all patients with thyroid pathology

No	Type of thyroid pathology	Radiological finding n (%)	Histopathological finding n (%)
1	Benign	50 (92.59)	48 (88.89)
2	Malignant	4 (7.41)	6 (11.12)

Table-3: Relation of radiological and pathological diagnosis in patients of study group

Sr. No.	Variable	Type of thyroid pathology		P value
		Benign n (%)	Malignant n (%)	
Composition				
1	Cystic	30 (55.55)	0	0.0018*
2	Mixed cystic & solid	14 (25.92)	2 (3.70)	
3	Solid/ cannot determine	4 (7.41)	4 (7.41)	
Echogenicity				
1	Anechoic	24 (44.44)	0	< 0.0001*
2	Hyperechoic/ Isoechoic/ cannot determine	16 (29.63)	0	
3	Hypoechoic	7 (12.96)	2 (3.70)	
4	Very hypoechoic	1 (1.85)	4 (7.41)	
Shape				
1	Not taller than wide	42 (77.78)	2 (3.70)	0.0006*
2	Taller than wide	5 (9.26)	4 (7.40)	
Margins				
1	Smooth/ill-defined/cannot determine	40 (74.07)	1 (1.85)	0.0001*
2	Lobulated/irregular	8 (14.81)	4 (7.41)	
3	Extra thyroid extension	0	1 (1.85)	
Echogenic FOCI (choose that apply, > 1 option)				
1	None/large comet tail artifacts	34 (62.96)	0	0.0001*
2	Macrocalcification	14 (25.92)	1(1.85)	
3	Peripheral calcification	4 (7.41)	3 (5.55)	
4	Punctate echogenic foci	5 (9.26)	4 (7.41)	
Peripheral HALO				
1	Present	36 (66.67)	1 (1.85)	0.03725
2	Absent	12 (22.22)	5 (9.26)	
P value < 0.05 – statically significant				

Table-4: Relation between pathology diagnosis according to level of TIRADS on ultra sound of the study group

No		TIRADS classification n (%)		Histopathological finding	P Value
		Benign n (%)	Malignant n (%)		
1	TR1	10 (18.52)	10 (18.52)	0	0.0918
2	TR2	26 (48.15)	26 (48.15)	0	0.0070*
3	TR3	10 (18.52)	9 (16.67)	1 (1.85)	0.9014
4	TR4	6 (11.11)	2 (3.70)	4 (7.40)	0.00004*
5	TR5	2 (3.70)	1 (1.85)	1 (1.85)	0.0745
Total		54	48 (88.89)	6 (11.12)	
* P value < 0.05- statically significant					

Table-5: Corelation of radiological finding according to ACR-TIRADS categories and histopathological finding

No	Type of thyroid pathology	Values n (%)
Benign		48 (88.89)
1	Colloid nodules	39 (72.22)
2	Follicular adenoma	5 (9.26)
3	Hyperplastic nodules	3 (5.55)
4	Lymphocytic thyroiditis	1 (1.85)
Malignant		6 (11.12)
1	Follicular carcinoma	3 (5.55)
2	Papillary carcinoma	2 (3.70)
3	Anaplastic thyroid carcinoma	1 (1.85)
Total		54

Table-6: Distribution of patients according to type of thyroid pathology

(7.41%/5.55%). All the ultrasonographic finding, according to composition, echogenicity, shape of gland, margins and echogenic foci was found statically significant (P value <0.05). Peripheral Halo (hypoechoic Rim) found to be present mainly in benign thyroid pathologies.

Table 5 depicts, all the thyroid pathologies, which categorized under TR1 & TR2 category were found to be benign thyroid pathologies on histopathological examination. From all benign thyroid pathologies majority of lesions were found to be in a category TR1 (18.52%) and TR2 (48.15%). (Image 1) (Image 2)

Majority (16.67%) of the lesions which fall under category

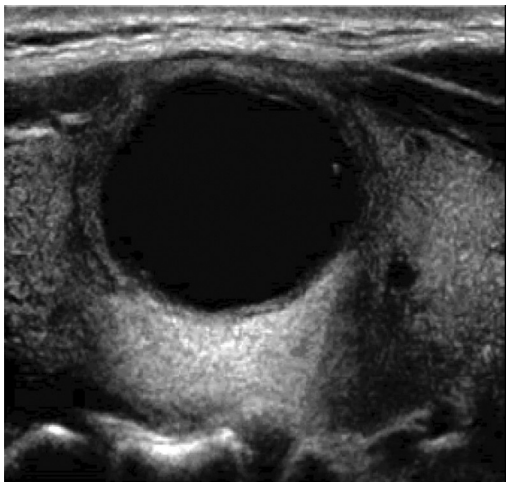


Image-1: TR1 – Completely anechoic nodule without internal solid component considered benign colloid cyst of thyroid gland

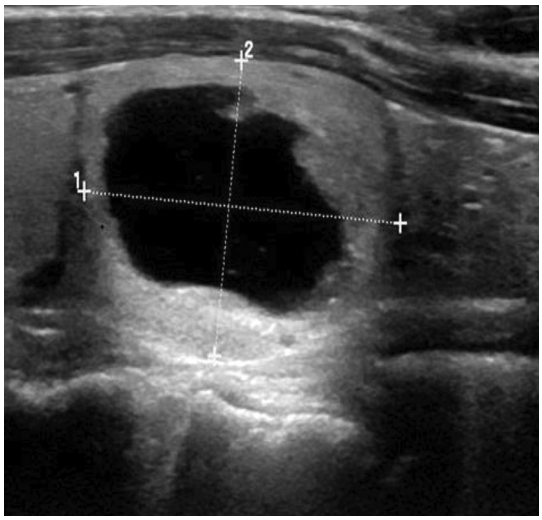


Image-2: TR2 – Anechoic well-defined nodule with peripheral isoechoic solid compound

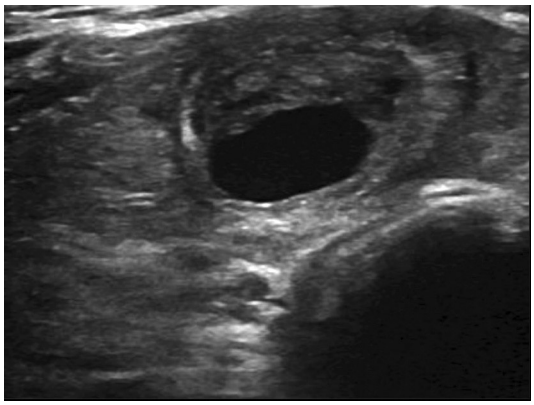


Image-3: TR3 – Hypoechoic mixed solid cystic composition of thyroid nodule FNA recalled benign nodular hyperplasia with cystic dysfunction

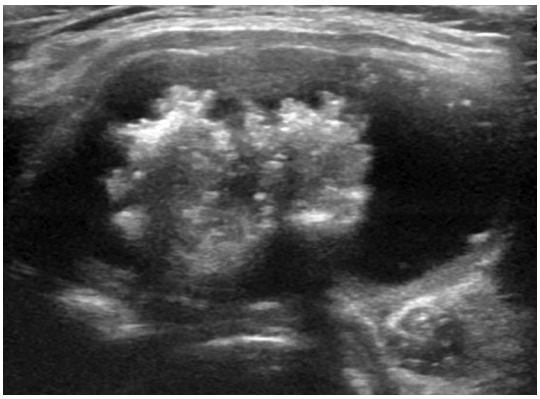


Image-4: TR4 – Solid isoechoic with irregular margin and punctuated echogenic nodule foci

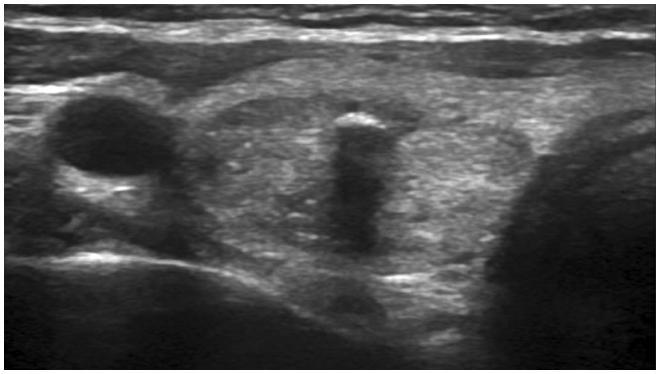


Image-5: TR5– Well defined solid hypoechoic nodule with macrocalcification and punctate calcification. Papillary carcinoma was found on specimen after surgical removal

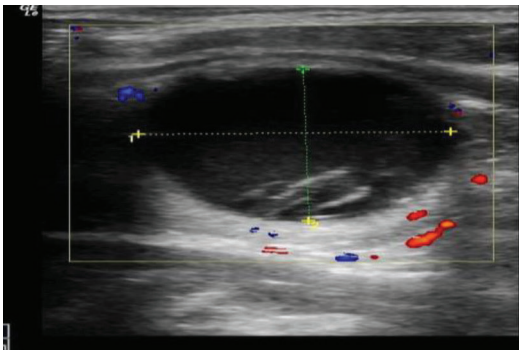


Image-6: Type-1 No color flow within

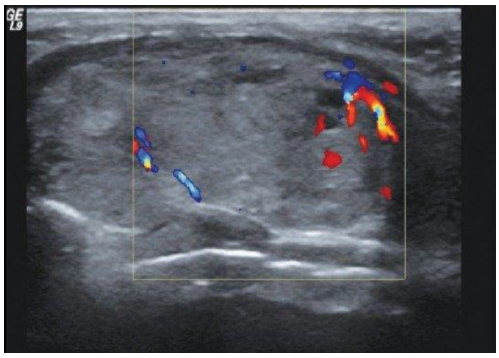


Image-7: Type-2 Minimal color flow

TR3 were benign thyroid pathologies where only 1 (1.85%) patient were found to have malignant thyroid pathology.
The TR4 category had the higher (7.40%) number of patients with malignant thyroid. (Image 4) Category of TR2 and TR4 were found to be statistically significant (P value < 0.05). Our findings in categories TR2 and TR4 demonstrating, higher accuracy of our radiological finding of thyroid pathology. Among TR5, 1 (1.85%) patient had benign thyroid pathology and 1 (1.85%) patient had malignant thyroid pathology.
Table-6 illustrate, distribution of thyroid patients according to type of pathology in histopathological finding. Out of 54 patients, Majority of 48 (88.89%) patients had benign thyroid pathology and 6 (11.12%) patients had malignant thyroid pathology. In benign pathology, 39 (72.22%) colloid nodules were most common and 3 (5.55%) follicular carcinomas in the malignant pathology
Figure – 1 showed, Type I and II color flow patterns are found mainly in benign thyroid pathologies and Type III and IV color flow patterns are found mainly in malignant thyroid pathologies.

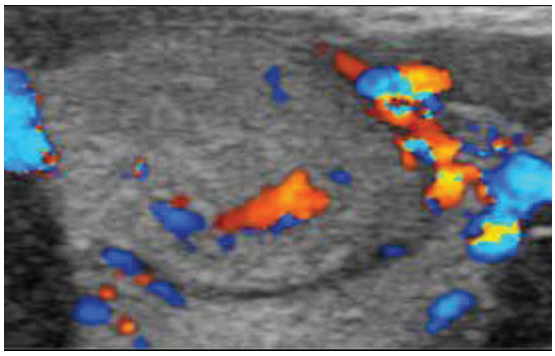


Image-8: Type-3 Peripheral and internal color flow

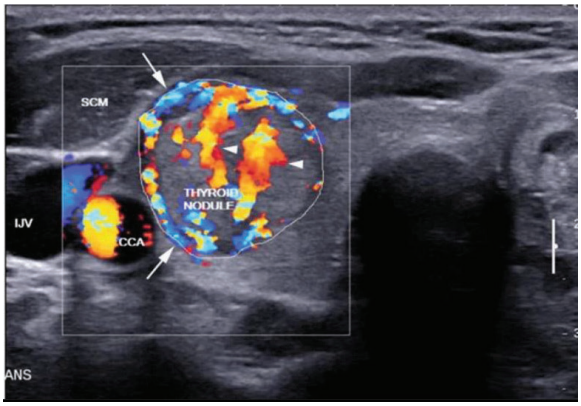


Image-9: Type-4 Marked internal and peripheral color flow

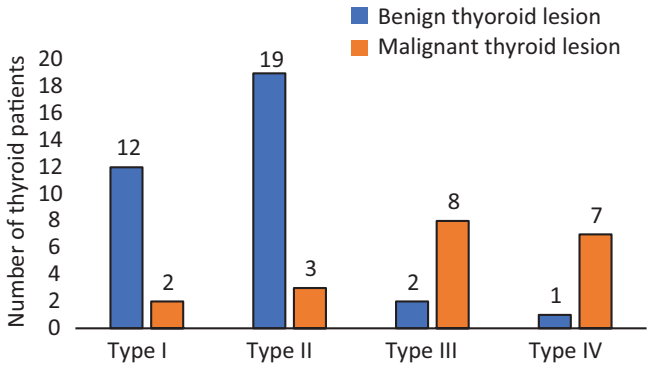
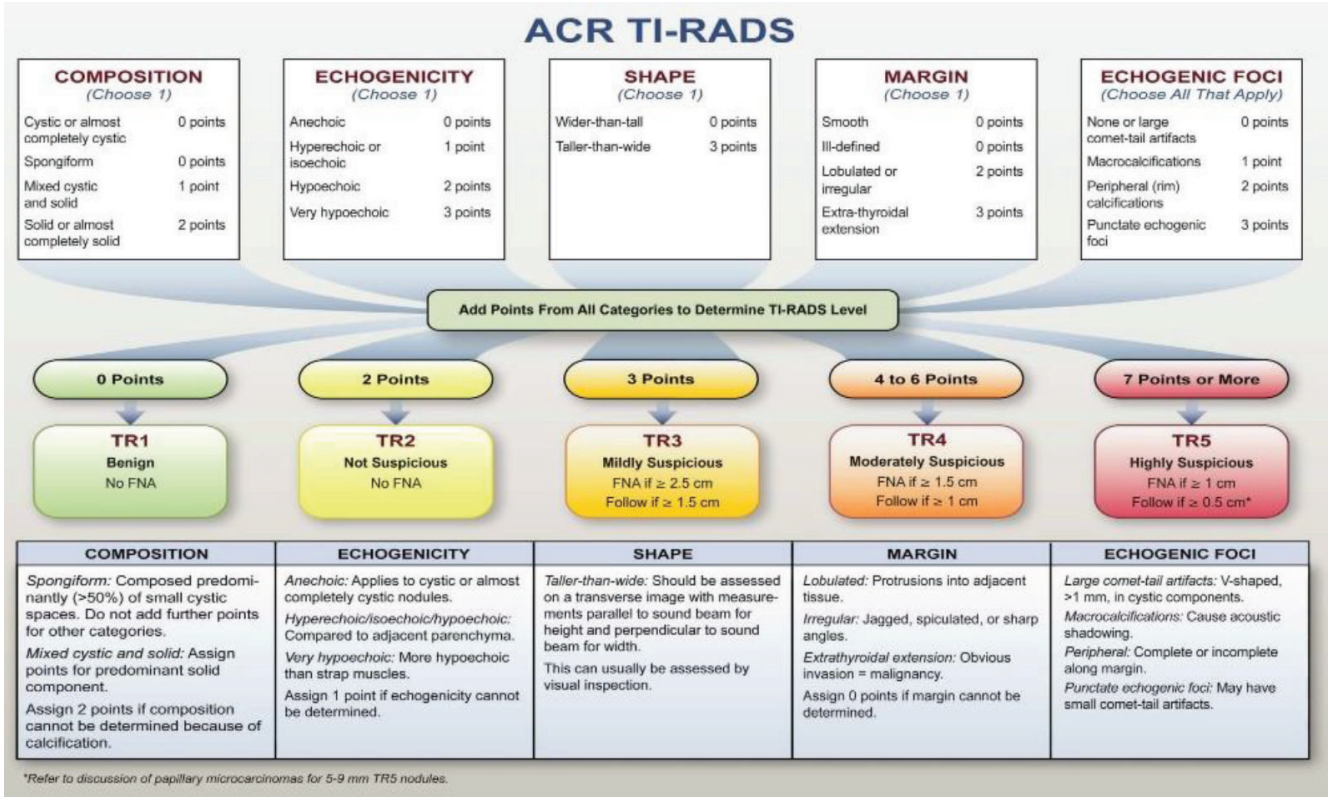


Figure-1: Color doppler finding according to type of thyroid cases



DISCUSSION

Since last decades, it drew interest to develop accurate USG reporting system, helpful to evaluate accuracy of USG reporting system & early detection and classify malignancy accurately. USG and color doppler are less expensive and useful tool to be used for initial assessment of thyroid gland. The present study was undertaken to evaluate the correlation between radiological finding on Ultrasonography and color doppler finding and histopathological finding. In ACR TIRADS classification, 5 compositions of thyroid gland are evaluated for diagnosis of benign and malignant thyroid pathology. This classification method is helpful to increase accuracy of radiological diagnosis.

Out of a total 54 patients, 48 (88.89%) patients had benign thyroid and 6 (11.12%) patients had malignant thyroid pathology. Majority (85.04%) of patients were females in benign and malignant thyroid pathology. According to Ortega J. et al.'s study, Females had 2.9 times higher chance to develop thyroid cancer than male.[9] In thyroid cancer incidence, aggressiveness and prognosis were more common in females.[10]

The majority (66.67%) of thyroid patients were from 21–40-year age group. Similarly, study conducted by Orosco et al. showed that age group of 25-55 years shows consistently higher percentage.[11]

There was only 1-1 patient in the TR3 and TR5 category of malignant thyroid pathology. Category of TR2 and TR5 were found to be statistically significant (P value < 0.05). Our findings in categories TR2 and TR4 demonstrating, higher accuracy of our study of radiological finding of thyroid pathology. Our USG finding accurately correlate with histopathological finding in both category of TIRADS.

Cystic composition of tumours was more common in benign thyroid lesions (55.55%) and solid or indeterminate composition of tumours (7.41%) were more common in malignant thyroids lesions. The composition of nodule appears that appears solid more likely they have malignant thyroid pathology. In echogenicity component, anechoic echogenicity was more frequent in benign thyroid lesions (44.44%), while very hypoechoic echogenicity was more seen in malignant thyroid pathology (7.41%). Very hypoechoic lesions are more likely to have malignant thyroid pathology, whereas anechoic lesions point towards benign pathology. A majority (77.78%) of benign thyroid lesions had wider thyroid gland. Higher (74.07%) percentage of benign thyroid pathology patients had smooth, ill-defined, or difficult-to-define thyroid margins. Whereas, no patients had extra thyroid extension. In malignant thyroid pathology, majority (4, 7.41%) of patients had lobulated/irregular margins. The lesions with irregular margins and extra thyroid extension are highly suggests malignant nature of lesion.

Higher (62.96%) percentages of benign thyroid disease were found to have large comet tail artefacts in form of echogenic foci in thyroid gland. Macrocalcification focus points towards benign pathology, where puncate echogenic foci/peripheral calcification points to malignant pathology. Punctate echogenic foci/peripheral calcification were seen higher (7.41%/5.55%) percentage in malignant thyroid pathology.

Similar study was conducted by Kumar A et al. using TIRAD classification for USG guide evaluation of benign and malignant thyroid pathology in 209 Bihar patients. It was found that majority of patients, who had benign thyroid pathology have solid (82), hypoechoic (132), defined margins (145), decrease vascularity (140), and multiple nodules (101).

In malignant thyroid pathology, majority of patients had solid (8), hypoechoic (10), poorly defined margins (13), Increase vascularity (13), and similar number patients had solitary (6) and multiple (6) nodules.[12]

Study conducted by Ghani F et al. found that patients had 92 (88.46) benign thyroid and 12 (11.54%) patients had malignant thyroid pathology out of 104 patients. Majority of patients of benign thyroid pathology had mixed solid cystic (47.8%), Isoechoic (67%), well defined (98.9%), and wider thyroid gland (95.7%). In malignant thyroid pathology, majority of patients had solid (75%), hypoechoic (83.3%), microcalcification (50%), well defined margins (91.7%), and wider thyroid gland (58.3%).[13]

Among 48 patients of benign thyroid lesions, 39 (72.22%) patients had colloid nodules, 5 (9.26%) patients had follicular adenoma, 3 (5.55%) had hyperplastic nodules and 1 (1.85%) had lymphocytic thyroiditis. Out of malignant thyroid pathology patients, 3 (5.55%) patients had follicular carcinoma, 2 (3.70%) patients had papillary carcinoma and only 1(1.85%) patient had anaplastic thyroid carcinoma.

Colour Doppler pattern is not sensitive and specific in differentiation of malignant and benign thyroid nodules in isolation. However, on combination with grey scale findings type III& IV pattern of flow increases the specificity of diagnosis of malignancy. In a study conducted by Singh D et al. reported majority (50%) of benign thyroid patients had no blood flow in nodule. Whereas, majority (12%) of malignant thyroid patients had Intramodular with or without peri nodular blood flow.[4]

Limitations

Chance of subjective variations.

As, we have smaller sample size the results of our study might vary compare to larger population studies.

CONCLUSION

ACR-TIRADS is appropriate classification system to evaluate to identify and subclassify thyroid pathology, which is helpful to avoid expensive and painful procedures. Thyroid pathology is more common in females, especially in middle age group, both benign as well malignant pathology. From benign thyroid pathologies colloid nodules were the most common one. In malignant thyroid pathologies, follicular carcinoma was the most common one, followed by papillary carcinoma and anaplastic type of carcinoma. The lesion, which on ultrasonography and color doppler study appear solid/solid cystic, very hypoechoic, taller than wider, with irregular margins, punctate echogenic foci or peripheral

calcification and internal ± peripheral color flow should be suspected for malignant lesion. And should undergo histopathological examination.

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