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A study of evaluation of focal thyroid nodule/nodules on ultrasound (Grey scale), color doppler and elastography with histopathological correlation

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Abstract

Background: Focal thyroid nodule/ nodules (TN) can either be benign or malignant. Only clinical and laboratory assessment are not sufficient to identify nature of thyroid nodule. So imaging is mandatory most of the time. Ultrasound is most widely used imaging technique as it is safe, cheap, time saving and highly sensitive and specific in many characteristic thyroid nodules. The color doppler provides good advantage to evaluate vascularity of thyroid nodules and also helps to differentiate benign and malignant lesions. Ultrasound-based elastography enables the determination of tissue elasticity and guides for the nature of the nodule.

Methodology: Patients of any age/ gender were included who were diagnosed having focal solitary/multiple thyroid nodule/ nodules primarily on Ultrasound, Color Doppler & Elastography study and Undergone Histopathological examination. All patients were excluded who didn't give consent for participation in the study & patients with diffuse disease of thyroid gland e.g. thyroiditis.

Results: Among 108 patients 100 were suspected to have benign thyroid nodule and 8 were suspected to have malignant thyroid nodule as per sonographic findings which well correlate with its histological findings as 96 nodules were found to be benign and 12 nodules were found to be malignant. Characteristics like wider than taller, smooth margins, anechoic to hyperechoic, with no / minimal color flow and appearing softer on elastography favors benignicity. However features like taller than wider, lobulated irregular marginated, hypoechoic to very hypoechoic, internal microcalcification, with significant internal and peripheral color flow and appearing stiffer on elastography favors malignancy.

Conclusions: Ultrasonography is very helpful to differentiate between benign and malignant thyroid nodule aided color Doppler and elastography findings. Strain Elastography has a high sensitivity and specificity in the evaluation of thyroid nodules. This technique might be useful in conjunction of FNA to select patients with thyroid nodules for surgery.

Keywords: Color doppler, elastography, thyroid nodule, ultrasonography

Introduction

Thyroid nodules 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. 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 [1]. About 3% to 8% of the population seems to have thyroid nodules, and beyond age 65, their prevalence rises to more than 50%.

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 like vascularity within the nodule are conducted using color Doppler sonography. Ultrasound (US) elastography has been introduced as a non-invasive technique for evaluating thyroid diseases.

Ultrasound (US) elastography has been dubbed "electronic palpation" because it offers an assessment of tissue consistency. Palpation is a useful diagnostic technique, presence of a hard thyroid nodule (TN) is associated with an increased risk of malignancy, but this assessment is subjective and depends on the experience of the examining clinician. Small and deep nodules and those contained in multinodular goiters cannot be reliably palpated.

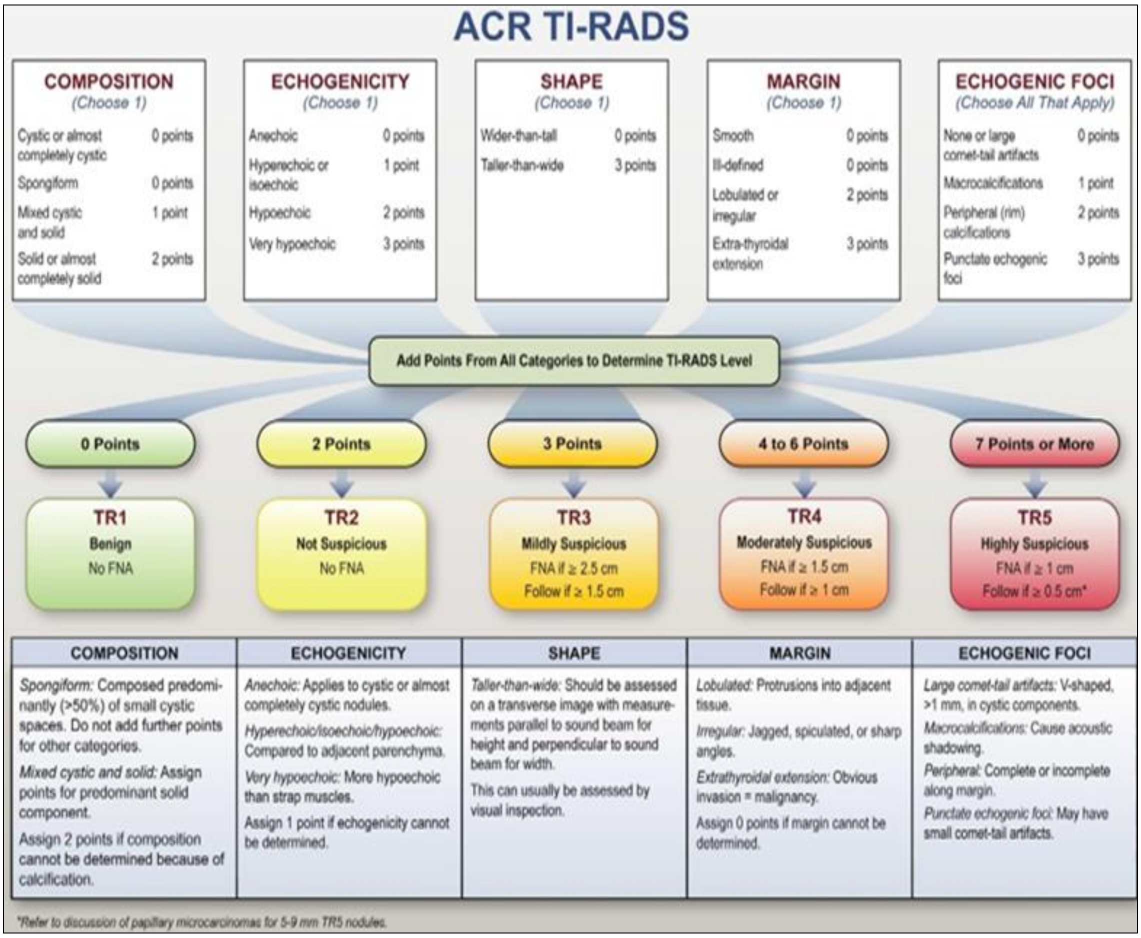
Ophir *et al*. first proposed US elastography in 1991 and was first used for thyroid applications in 2005 by Lyshchik *et al*. [9] Elastography determines the stiffness of a tissue by the structural properties of its matrix. Pathological changes, such as the presence of a tumor or inflammation, alter the tissue composition and structure and increase the lesion stiffness [9]. The standard work-up of TNs consists of a US examination and fine-needle aspiration (FNA), but both have limitations.US elastography has been a useful tool in the continual search for appropriate non-invasive diagnostic techniques, complementing US and FNA for TN distinction. The goal of this study is to assess the results of Ultrasonography, Color Doppler, and Elastography in various thyroid nodules and correlate them with histopathological findings in order to increase the accuracy of the diagnosis that is provided. This article discusses the technological basis, characteristics, and constraints of US elastography methods, particularly strain elastography.

The 2016 AACE guidelines [9] stated that US elastography provides stiffness information, which is complementary to grayscale findings, particularly in nodules with indeterminate US or cytologic characteristics. Moreover, FNA is recommended for nodules with increased stiffness, an intermediate-risk factor. The 2013 EFSUMB guidelines [9] stated that US elastography could be used to guide the follow-up of lesions diagnosed as benign at FNA.

Materials and Methodology

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, who were diagnosed having thyroid nodule/nodules (focal mass lesion) primarily on ultrasonography, color doppler and elastography at radiology department of L.G. General Hospital and also, same patients, who undergone histopathological examination (USG guided FNAC/ surgical excisional biopsy) for confirmation of diagnosis. Patients with multiple thyroid nodules were evaluated for the largest nodule. We excluded patients, who were not giving consent for participation and not undergone histopathological examination. Study was conducted over a period of April, 2023 to September, 2023. The collected data was entered in Microsoft excel sheets and appropriate statistical test were used for data analysis.

The thyroid gland and neck were scanned using an L12-5 linear probe with an optimum gain on an AFFINITI 70 G Phillips Ultrasound machine. The terms "hyperechogenicity," "isoechogenicity", "hypoechogenicity" and "very hypoechogenicity" were used to categorize echogenicity; the term "isoechogenicity" refers to echogenicity that is comparable to that of the thyroid gland next to it in a healthy thyroid gland; if the echogenicity of a nodule was lower than that of the superficial surrounding neck muscles, it was classified as "very hypoechoic." 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 [3].



Principles of US Elastography Techniques in the Thyroid

Depending on which physical quantities are measured, there are two main thyroid elastography methods in clinical practice: strain elastography (SE) and SWE (Fig. 1). They can be classified into different variants based on the excitation method (external force, internal force, and acoustic radiation force [ARF]) and how stiffness is expressed (Fig. 2).

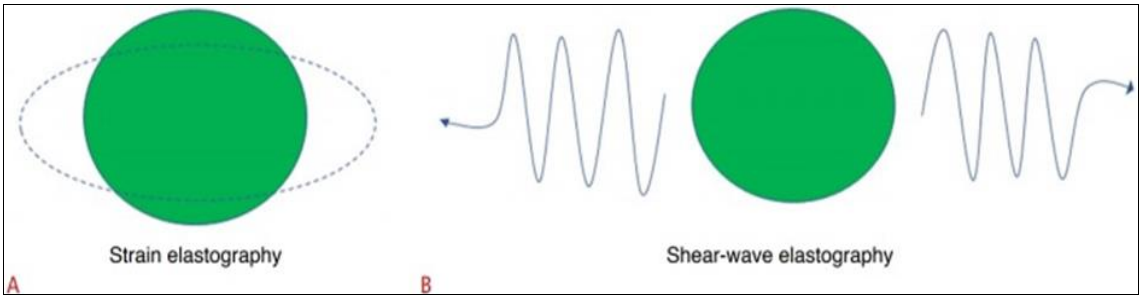


Fig 1: Principles of strain elastography and shear-wave elastography

A. Strain elastography assesses tissue elasticity by displacement of tissue induced by compression. B. Shear-wave elastography assesses tissue elasticity through measurement of propagation speed of transverse shear waves.

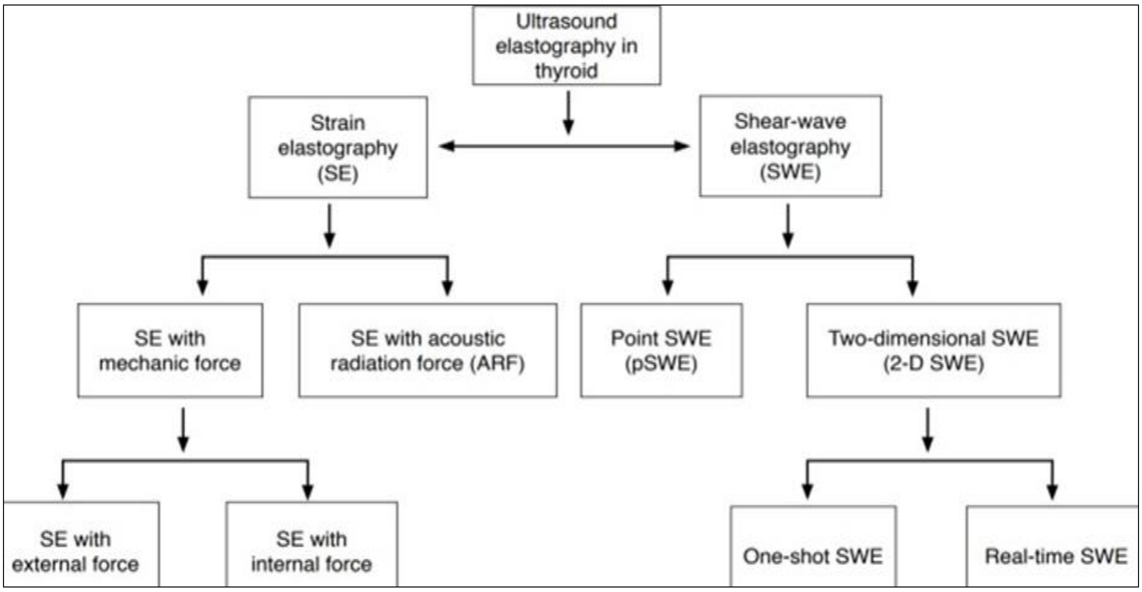


Fig 2: Classification of ultrasound elastography of the thyroid

Ultrasound elastography of the thyroid can be classified into different variants according to the excitation method and way that stiffness is expressed.

Strain Elastography

To evaluate the relationship between compression and strain, the Young modulus (*E*), also known as the ratio of stress (σ) to strain (ε), *E* can be calculated using Equation, E = σ ε.

Mechanical tension is necessary for SE, and this causes the tissue to shift axially9. Stress-induced tissue deformation is quantified and displayed on a screen. Operator-dependence for the compression angle, strength, and duration is one of SE's primary drawbacks.

SE can yield two types of elasticity evaluations. First, a 4- and 5-point elasticity score (ES) system can be applied, using a visual scoring system of colors inside and around the nodules. Secondly, the target region and a nearby reference region are designated as two regions of interest (ROIs). The strain ratio (SR) is then automatically calculated [10].

A. The elastographic image is acquired through tissue displacement caused by free-hand compression with a transducer. B. The strain image is generated through tissue displacement induced by compression caused by carotid artery pulsation. C. The transducer is used to generate an acoustic radiation force push pulse to excite the target tissue and to monitor the tissue deformation.

Qualitative assessment

The ES is usually calculated using the 5-point Rago criteria (Fig. 4) or the 4-point Asteria criteria [9], based on the predominant color pattern of the nodule.

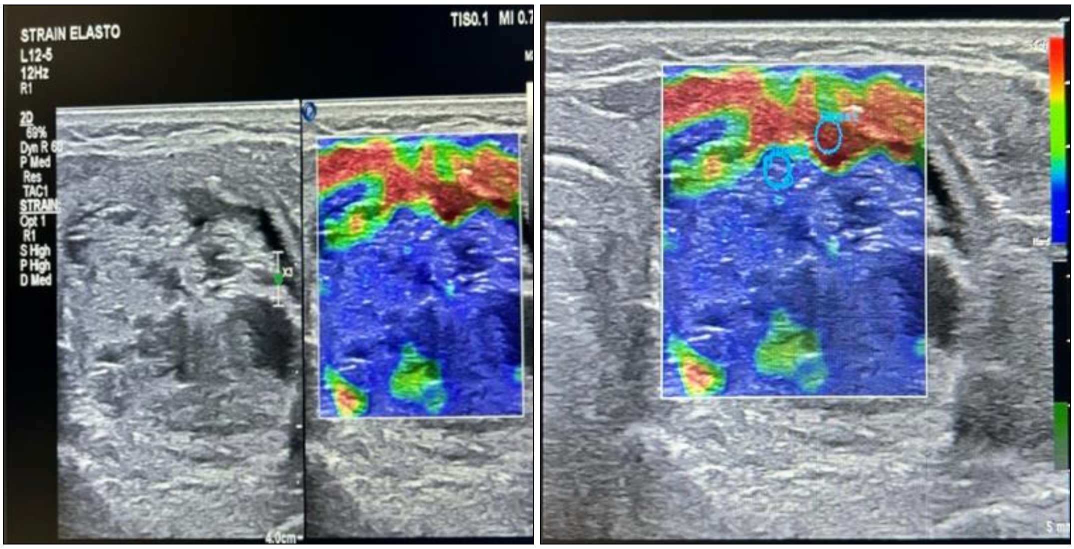


Image 1: Showing strain elastography in a thyroid nodule which is showing color coding for stiffness: red for hard, green for intermediate and blue for soft tissue and image 2 is showing comparison of two ROI which gives automatically calculated Strain ratio

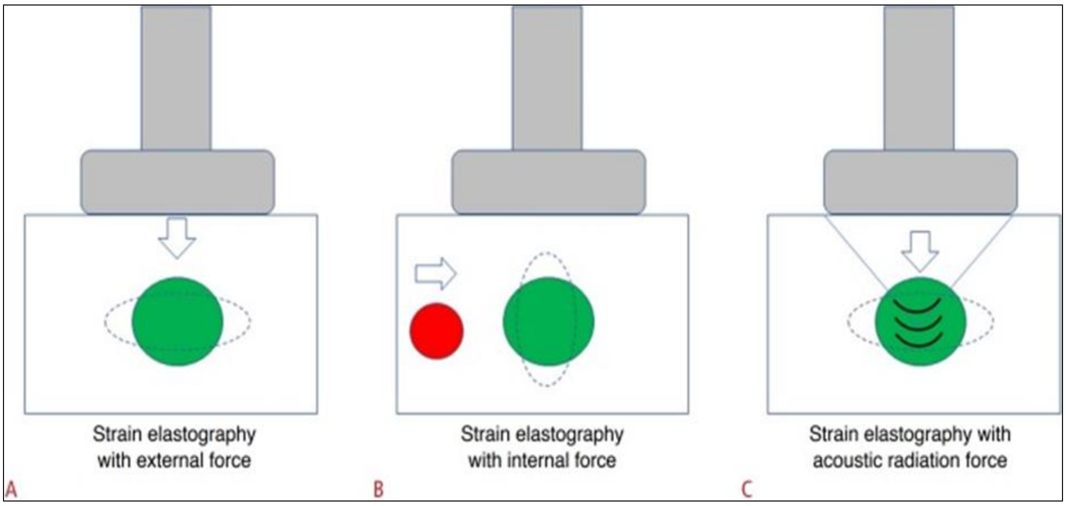


Fig 3: Principles of different strain elastography techniques using different excitation methods

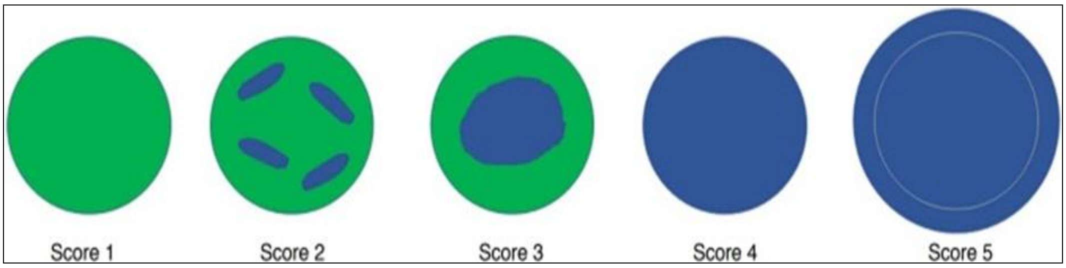


Fig 4: The 5-point Rago criteria for strain elastography of thyroid nodules.

A score of 1 indicates even elasticity throughout the whole nodule, a score of 2 indicates elasticity in a large part of the nodule, a score of 3 indicates elasticity only at the peripheral part of the nodule, a score of 4 indicates no elasticity in the nodule, and a score of 5 indicates no elasticity in the nodule or in the area showing posterior shadowing.

Machine specific criteria for qualitative strain elastography: red for hard, green for intermediate and blue for soft tissue

Practical Clinical Applications

Strain Elastography to be useful for the assessment of malignancy, with an overall mean sensitivity of 92% and mean specificity of 90% [9]. In real clinical practice, US elastography is usually performed as an extension of conventional US and not as an independent test. Most reports have stated that a combination of conventional US and elastography showed higher sensitivity than conventional US alone.

Results

Among 108 patients having thyroid nodules, 96 (88.89%) nodules & 12 (11.12%) nodules were found to be benign and malignant respectively. The sensitivity, specificity, positive predictive value & negative predictive value (NPV) were 100%, 91.3%, 66% & 96%.

Table 1 a): Demographic details of all patients with thyroid nodular lesions (n=108)

Variable		Type of Thyroid Nodule confirmed by histopathological examination		Total n (%)
		Benign n (%)	Malignant n (%)	
Gender	Female	82 (75.92)	12 (11.12)	94 (87.04)
	Male	14 (12.96)	0	14 (12.96)
Age (Years)	< 20	4 (3.70)	0	4 (3.70)
	21-40	70 (64.81)	2 (1.85)	72 (66.67)
	41-60	20 (18.52)	8 (7.41)	28 (25.92)
	> 60	2 (1.85)	2 (1.85)	4 (3.70)
Total		96 (88.89)	12 (11.12)	108 (100)

Table 1 (a) showed that a total of 108 patients was diagnosed with thyroid nodules, the majority (87.04%) of these patients were female patients, whereas just 14 (12.96%) male patients were reported in our study. 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 25.92%. No patient was found be suffering from malignant thyroid nodule below 20-year age. Higher (75.92%) percentage of female patients were found to have benign thyroid nodule. Out of a total 108 patients, 96 (88.89%) patients had benign and 12 (11.12%) patients had malignant thyroid nodule.

Table 1 b): Demographic details of patients with benign thyroid nodular lesions confirmed by histopathological examination (n=96)

Variable		Benign n (%)
Gender	Female	82 (85.42)
	Male	14 (14.58)
Age (Years)	< 20	4 (4.17)
	21-40	70 (72.92)
	41-60	20 (20.83)
	> 60	2 (2.08)
Total		96 (100)

Table 1: c) Demographic details of patients with malignant thyroid nodular lesions confirmed by histopathological examination (n=12)

Variable		Malignant n (%)
Gender	Female	12 (100)
	Male	0
Age (Years)	< 20	0
	21-40	2 (16.67)
	41-60	8 (66.67)
	> 60	2 (16.67)
Total		12 (100)

Table 1 (b): Among 96 benign thyroid nodule 82 were found in female patient and most commonly in 21-40 years of age group. Table 1 (c): In case of malignant thyroid nodule, 12 females were found to be affected in our study. In which, majority (8) of patients were from 41 to 60 years, followed by equal number of patients in the age group of 21 to 40 years (2) and more than 60 years (2).

Table 2: Relation of radiological (ultrasound) and pathological diagnosis in patients of study group (n=108)

No.	Type of thyroid nodule	Radiological finding n (%)	Histopathological finding n (%)
1.	Benign	100 (92.59)	96 (88.89)
2.	Malignant	8 (7.41)	12 (11.12)
Total		108	108

According to Table 2, a total of 100 (92.59%) patients were found to have benign thyroid nodules on USG finding. Whereas, histological finding showed 96 (88.89%) patients had benign thyroid nodules. Similarly, malignant thyroid nodules were found in 8 (7.41%) patients in radiological finding. In histopathological finding, a total of 12 (11.12%) patients were found to have malignant thyroid pathology. Among 8 patients which were suspected radiologically for having malignant nodules, correlated 100% with histopathological findings. Mismatch between radiological and histological findings were found in 4 patients, where radiologically suspected benign lesions were diagnosed as malignant lesions.

Table 3: Corelation of radiological finding according to ACR-TIRADS categories and histopathological finding (n=108)

No	Tirads Classification n (%)		Histopathological finding		P value
			Benign n (%)	Malignant n (%)	
1	TR1	20 (18.52)	20(18.52)	0	0.0918
2	TR2	52 (48.15)	52 (48.15)	0	0.0070*
3	TR3	20 (18.52)	18 (16.67)	2 (1.85)	0.9014
4	TR4	12(11.11)	4 (3.70)	8 (7.40)	0.00004*
5	TR5	4 (3.70)	2 (1.85)	2 (1.85)	0.0745
Total		108	96 (88.89)	12 (11.12)	

* P value < 0.05- statistically significant

Table 3 depicts, all the thyroid nodules, which categorized under TR1 & TR2 category were found to be benign thyroid nodules on histopathological examination. From all benign thyroid nodules 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 TR3 (18.52%) were benign thyroid nodules where only 2 (1.85%) patients were found to have malignant thyroid nodules. 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 nodule. Among TR5, 2 (1.85%) patients had benign thyroid nodules and 2 (1.85%) patients had malignant thyroid nodules.

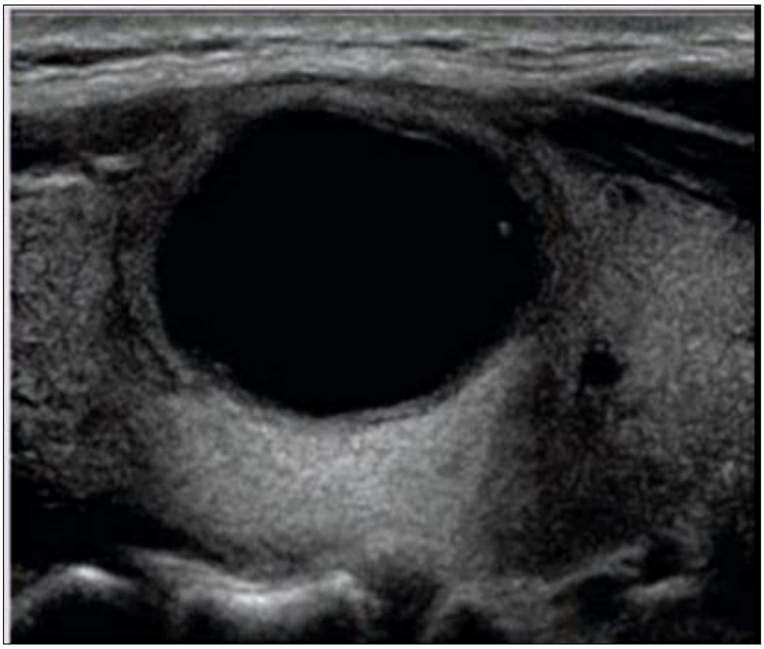


Image 1: TR1 - Completely anechoic nodule without internal solid component considered benign colloid cyst of thyroid gland

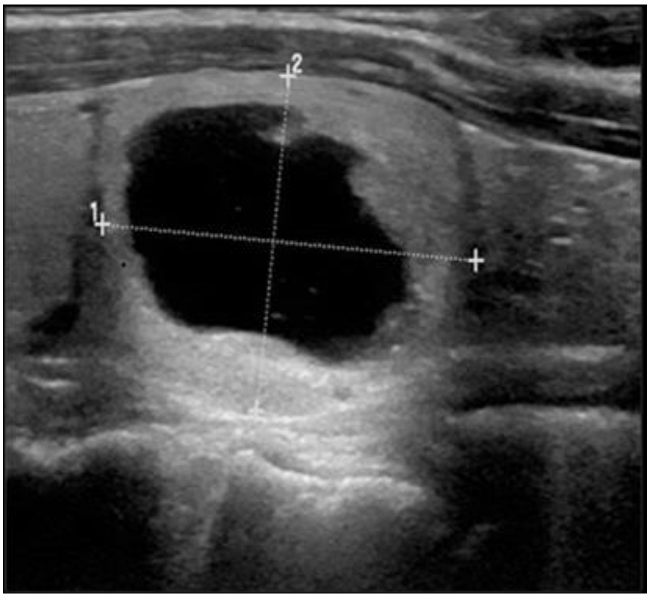


Image 2: TR2-Anechoic well-defined nodule with peripheral isoechoic solid com pound

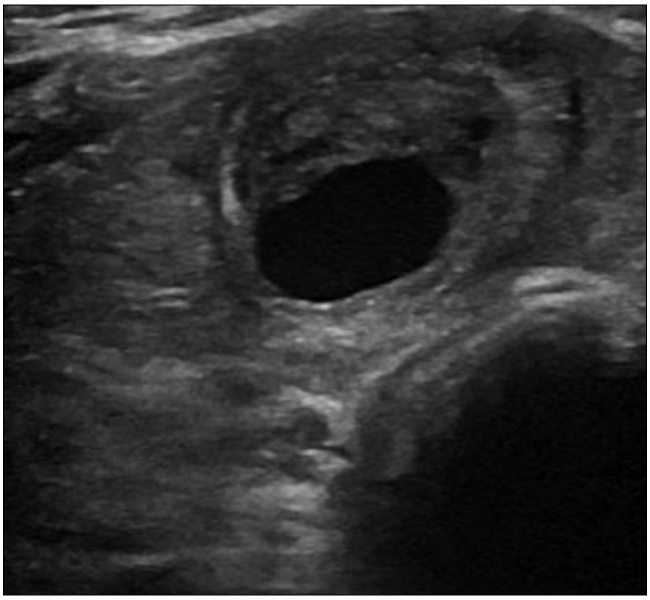


Image 3: TR3 – Hypoechoic mixed solid- cystic composition of thyroid nodule, FNAC suggestive of benign nodular hyperplasia with cystic changes

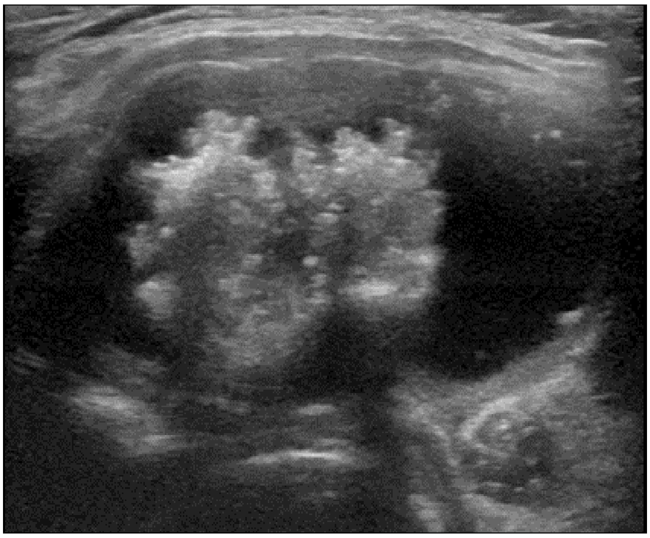


Image 4: TR4 - Solid isoechoic nodule with irregular margin and punctuated internal echogenic foci and surrounding cystic area

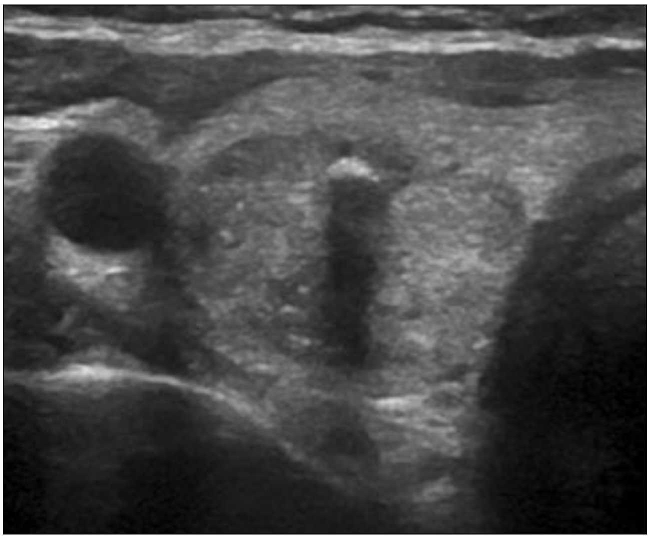


Image 5: TR5– Well defined solid hypoechoic nodule with macrocalcification and punctate calcification. Papillary carcinoma was found on histopathological examination on specimen after surgical removal

Table 4: Relation between Ultrasound (Grey Scale, Color Doppler & Strain Elastography) findings & nodule diagnosis of the study group (n=108) P value < 0.05 – statically significant

Sr. No.	Variable	Type of thyroid nodule		P value
		Benign n (%)	Malignant n (%)	
Composition				
1.	Cystic	60 (55.55)	0	0.00012
2.	Mixed cystic & solid	28 (25.92)	4 (3.70)	
3.	Solid/ cannot determine	8 (7.41)	8 (7.41)	
Echogenicity				
1.	Anechoic	48(44.44)	0	< 0.001
2.	Hyperechoic/ Isoechoic/ cannot determine	32 (29.63)	0	
3.	Hypoechoic	14(12.96)	4 (3.70)	
4.	Very hypoechoic	2 (1.85)	8 (7.41)	
Shape				
1.	Not taller than wide	84 (77.78)	4 (3.70)	< 0.0001
2.	Taller than wide	10 (9.26)	8 (7.40)	
Margins				
1.	Smooth/ill-defined/cannot determine	80 (74.07)	2 (1.85)	< 0.0001
2.	Lobulated/irregular	16 (14.81)	8 (7.41)	
3.	Extra thyroid extension	0	2 (1.85)	
Echogenic Foci (Choose That Apply, > 1 Option)				
1.	None/large comet tail artifacts	68 (62.96)	0	< 0.0001
2.	Macrocalcification	28 (25.92)	2(1.85)	
3.	Peripheral calcification	8 (7.41)	6 (5.55)	
4.	Punctate echogenic foci	10 (9.26)	8 (7.41)	
Vascularity-assessed on colordoppler				
1.	Type 1 No vascularity	27(25.00)	0	< 0.001
2.	Type 2 Minimal vascularity	60 (55.56)	0	
3.	Type 3 Internal & perinodular vascularity	9 (8.34)	8 (7.40)	
4.	Type 4 Marked internal and peripheral vascularity	0	4 (3.70)	
Strain Elastography Score-Rago criteria				
1.	Score 1	25 (23.15)	0	< 0.0001
2.	Score 2	50 (46.30)	0	
3.	Score 3	16 (14.81)	1 (0.93)	
4.	Score 4	5 (4.63)	7 (6.48)	
5.	Score 5	0	4 (3.70)	
Elastography – Strain Ratio				
1.	< 0.5	27 (25.00)	0	< 0.0001
2.	0.6-1.5	54 (50.00)	0	
3.	1.6-2.5	14(12.96)	2 (1.85)	
4.	2.6-3.5	1 (0.93)	4 (3.70)	
5.	> 3.5	0	6 (5.56)	

Table 4 shows, evaluation of benign and malignant lesions of thyroid on USG according to TIRADS classification. Majority of benign thyroid nodule had Cystic (55.55%), anechoic (44.44%), smooth/ill-defined margins (74.07%), and large comet tail artefacts (62.96%). Majority of malignant thyroid nodules are solid in composition (7.41%), very hypoechoic (7.41%), had lobulated/irregular margins (7.41%), and punctate echogenic foci/peripheral calcification (7.41%/5.55%). In this study the lesion which were considered cystic/anechoic, contained few or none internal echoes. All the ultrasonographic finding, according to composition, echogenicity, shape of nodule, margins, echogenic foci, vascularity and strain elastography findings was found statically significant (P value <0.05). Cystic composition of tumor was more common in benign thyroid lesions (55.55%) and solid or indeterminate composition of tumor (7.41%) were more common in malignant thyroids lesions. The composition of nodule that appears solid are more likely they have malignant thyroid nodule. In echogenicity component, anechoic echogenicity was more frequent in benign thyroid lesions (44.44%), while very hypoechoic echogenicity was more seen in malignant thyroid nodule (7.41%). A majority (77.78%) of benign thyroid lesions had wider thyroid nodule. Higher (74.07%) percentage of benign thyroid nodules had smooth, ill-defined, or difficult-to-define thyroid margins. Whereas, no patients had extra thyroid extension. In malignant thyroid nodule, majority (7.41%) of them 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 nodule were found to have large comet tail artefacts in form of echogenic foci in thyroid gland. Macrocalcific focus (25.92%) points towards benign nodule, where punctate echogenic foci/peripheral calcification points to malignant nodule. Punctate echogenic foci/peripheral calcification were seen mainly (7.41%/5.55%) in malignant thyroid nodule.

Colour Doppler pattern alone is not sensitive and specific in differentiation of malignant and benign thyroid nodules. 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 patient with benign thyroid nodule had no blood flow in nodule. Whereas, majority of patients with malignant thyroid nodule had intranodular with or without perinodular blood flow [8].

Table 4 also depicts, all the thyroid nodules, which categorized under SE score 1 & 2 and SR <1.5 were found to be benign on histopathological examination. From all benign thyroid nodules majority of lesions were found to be of SE score 2 (46.30%) and SR of 0.6-1.5 (50%). Majority of the lesions which categorize SE score 3 (14.81%) and SR 1.6-2.5 (12.96%) were benign thyroid nodules where only 1 (0.93%) & 2 (1.85%) patients were found to have malignant thyroid nodule respectively. The SE score 4 category had the higher (6.48%) number of patients with malignant thyroid nodule. Nodules with SR of 2.6-3.5 had predominantly (3.70%) malignant nodules and SR > 3.5 had all malignant nodules.

Image 6 & 7 shows, Type I and II color flow patterns, which are found mainly in benign thyroid nodules and Image 8 & 9 shows, Type III and IV color flow patterns, which are found mainly in malignant thyroid nodules.

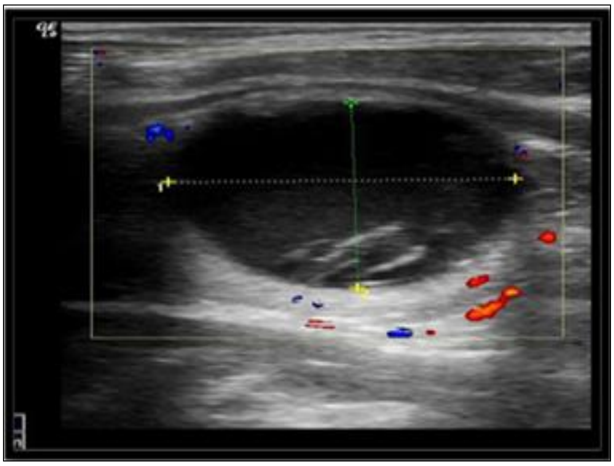


Image 6: Type-1 no color flow within

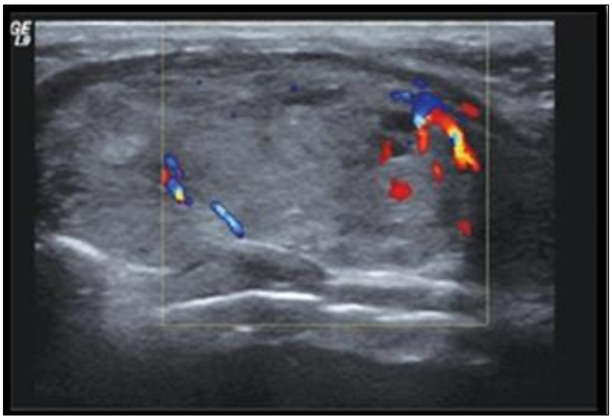


Image 7: Type-2 minimal color flow

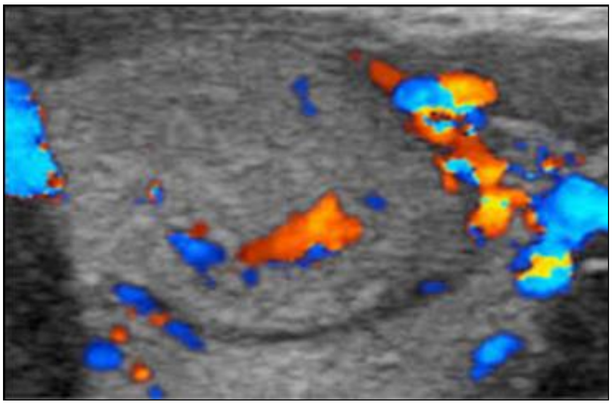


Image 8: Type-3 Peripheral and internal color flow

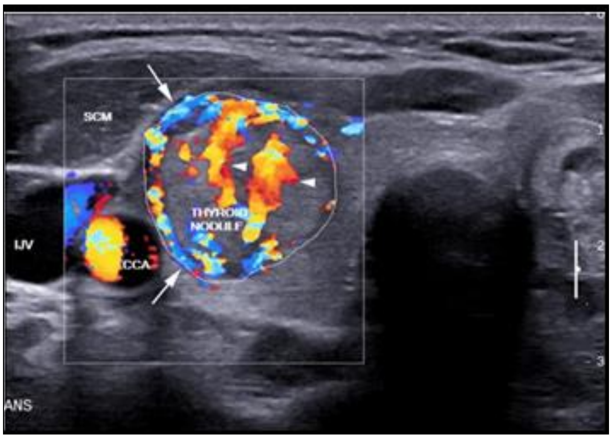


Image 9: Type-4 Marked internal and peripheral color flow

Table 5: Distribution of patients according to type of thyroid nodule (n=108)

No.	Type of thyroid nodule	Values n (%)
Benign		96 (88.89)
1.	Colloid nodules	78(72.22)
2.	Follicular adenoma	12(9.26)
3.	Hyperplastic nodules	6(5.55)
Malignant		12 (11.12)
1.	Follicular carcinoma	6 (5.55)
2.	Papillary carcinoma	4 (3.70)
3.	Anaplastic thyroid carcinoma	2 (1.85)
Total		108

Table 5 illustrate, distribution of thyroid patients according to type of nodule in histopathological finding. Out of 108 patients, Majority of (96, 88.89%) patients had benign thyroid nodule and 12 (11.12%) patients had malignant thyroid nodule. In benign nodule, colloid nodules were most common finding (72.22%) and follicular carcinomas were the most common finding (5.55%) in the malignant nodule.

Discussion

The development of an accurate USG reporting system has garnered attention in recent decades, as it can aid in early cancer identification and correctly classify malignancy. The thyroid gland can be initially assessed with less expensive and more beneficial tools such as USG, color doppler and elastography. The goal of the current investigation was to assess the relationship between radiological (ultrasound) findings and histopathological findings. Five thyroid gland components are assessed in the ACR TIRADS classification in order to diagnose benign and malignant thyroid nodules. The accuracy of radiological diagnosis can be improved with the use of this classification technique.

The prevalence of thyroid cancer in our sample population of nodules of 11.12% is comparable to other studies, which ranges from 5-15%, depending on sex, age and exposure to the risk factors [4]. The presence of some US features had earlier been described as highly suspicious of malignancy, and they include very hypoechoic, a taller than wide shape, irregular margins and the presence of calcifications [4]. In our study, 7.41% and 1.85% of malignant nodules contained punctate and macro calcifications respectively, and were either hypoechoic or very hypoechoic with percentages of 3.70% and 7.41% respectively. Nodules with internal and peripheral vascularity - Type 3 & 4 were found to be malignant predominantly, 7.40% & 3.70% respectively. However, central vascularity and lobulated margins were not very specific to either benign or malignant thyroid nodules. Kim *et al* found that a solid thyroid nodule that is taller than wide has high specificity of 93%, but however low sensitivity for malignancy has. The growth of most benign nodules have been found to stay within normal tissue planes, whereas malignant nodules grow across normal tissue planes. This appearance is thought to be due to a centrifugal predisposition in tumor growth, which does not certainly occur at a uniform rate in all dimensions[4]. It is important to emphasise that no single sonographic feature should be used to differentiate between benign and malignant nodule. Instead, the overall appearance and collective features of the thyroid nodule should be considered for diagnosis. According to Ortega J. *et al.*'s study, Females had 2.9 times higher chance to develop thyroid cancer than male. In thyroid cancer incidence, aggressiveness and poor prognosis were more common in females. Similarly, study conducted by Orosco *et al.* showed that age group of 25-55 years shows consistently higher percentage [5]. Similar study was conducted by Kumar A *et al.* using TIRAD classification for USG guide evaluation of benign and malignant thyroid nodule in 209 Bihar patients. It was found that majority of patients with benign thyroid nodule, have cystic-solid (82), iso-hyperechoic (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) [6].

US Elastography examinations of the thyroid are easily integrated into conventional US examinations; which takes only a few extra minutes and doesn't require any separate patient preparation, the patient experiences no pain during this procedure. Because of its high NPV, US elastography has the potential to distinguish benign from malignant TNs, offering non-invasive complementary resorting to FNA (fine needle aspiration) or surgery; it may be especially helpful in patients whose FNA cytology results are non-diagnostic or indeterminate. US elastography plays a major role in determining which nodules can be followed with imaging without FNA, with a high NPV [9].

A meta-analysis of eight studies with 486 indeterminate-cytology TNs demonstrated pooled sensitivity, specificity, and accuracy of 69%, 75%, and 73%, respectively, for SE [9]. The technology is still under development [2], and additional validation will be necessary with large cohort and multi-center prospective studies to evaluate reproducibility, different TN characteristics& uncommon nodules. Lin *et al.* [9] proposed an effective predictive model including elastography for identifying malignant TNs in patients with non-diagnostic cytologic findings.

Limitations

Chance of subjective variations. Influencing factors for elastography such as nodular size, composition & calcification, motion artefact by carotid artery pulsation, and pathological type of thyroid cancer. 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 sub classify thyroid nodule, which is helpful to avoid painful &expensive procedures. Thyroid nodules are more common in females, especially in middle age group, both benign as well malignant. Among benign nodules colloid nodules were the most common one & in malignant thyroid nodules, follicular carcinoma was the most common one, followed by papillary carcinoma and anaplastic type of carcinoma. The nodule, 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 and hard on elastography with strain ratio of 2.6 to 3.5 or above 3.5 should be suspected for malignancy & should undergo histopathological examination.

Conflict of Interest

Not available

Financial Support
Not available

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