

To Evaluate the Diagnostic Accuracy of Ultrasound Criteria for the Depiction of Benign or Malignant Thyroid Nodule by Using Tissue Diagnosis as Reference Standard

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Abstract

Background: High-resolution ultrasonography is a very sensitive imaging modality for examination of the thyroid gland and associated abnormalities. It is noninvasive, widely available, less expensive, and does not use any ionizing radiation. Further, real time ultrasound imaging helps to guide diagnostic and therapeutic interventional procedures (FNAC and Biopsy) in cases of thyroid disease. Objectives: To study the diagnostic accuracy of ultrasound criteria's for the depiction of benign or malignant thyroid nodule and their correlation with cytology or histopathology. **Subjects and Methods:** The study included 50 patients who were referred for ultrasound with clinical suspicion of thyroid lesions. The ultrasound diagnosis was compared to the final diagnosis made on cytology or histopathology, and the ability of ultrasound in differentiating between a benign or malignant lesion was determined. **Results:** The ultrasound features favoring a malignant lesion included – solid consistency (Sn 92.3%; Sp48.6%; p=.009), hypoechoic echo-pattern (Sn 100%; Sp 54.5%; p=.004), microcalcification (Sn 69.3%; Sp97.3%; p=.000), taller than wider shape (Sn 53.8%; Sp 89.1%; p=.001), ill-defined margins (Sn 61.5%; Sp 91.9%; p=.000) and internal vascularity (Sn 84.6%; Sp67.5%;p=.001). The ultrasound diagnosis was in agreement with the final diagnosis in 90% of the cases. The overall sensitivity, specificity and PPV of ultrasound in identifying a malignant lesion was 92.31%, 97.30%, and 92.31% respectively. **Conclusion:** Ultrasound is an excellent non-invasive modality to evaluate thyroid nodules. It is a highly sensitive imaging modality for identifying and characterizing a lesion as benign or malignant.

Keywords: Echogenicity, Ultrasound, Microcalcification, Colour Doppler.

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Introduction

Thyroid diseases are one of the commonest endocrine disorders worldwide and about 42 million people in India suffer from thyroid diseases.^[1] The spectrum of thyroid disorders includes functional disorders i.e. hyper- and hypothyroidism and structural abnormalities. e. Benign and malignant thyroid nodules.^[2] Incidence of all thyroid diseases is higher in females than males.^[3]

On Ultrasonography, normal thyroid tissue appears homogeneously echogenic with a uniform echo-texture.^[4] Fujimoto et al in 1967 were the first to describe detection and characterization of thyroid nodules by ultrasound.^[5] Moreover, with the availability of 7–15MHz high-frequency transducers, the detection of very small thyroid lesions (2–3mm) have become easy.^[6] Ultrasound scanning is non-invasive, widely available, less expensive, and does not use any ionizing radiation. Further, real-time ultrasound imaging helps to guide diagnostic and therapeutic interventional procedures in cases of thyroid disease. The major limitation of ultrasound in thyroid imaging is that it

cannot determine thyroid function, i.e., whether the thyroid gland is underactive, overactive or normal in function.^[7]

Although there is some overlap between the ultrasound appearance of benign and malignant nodules, certain US features are helpful in differentiating the two. It is therefore important to evaluate the sonographic features of thyroid nodules as they help in their characterization.^[7]

Echogenicity

The incidence of malignancy is 4% if a thyroid nodule is hyperechoic and it rises to 26% if it is hypoechoic.^[8] When a thyroid nodule is markedly hypoechoic, with a darker appearance than that of the infrahyoid or strap muscles of the neck, the specificity for detection of malignancy is increased to 94%, but the sensitivity is reduced to 12%. Marked hypo-echogenicity is very suggestive of malignancy.^[9] However, hypo echogenicity alone is inaccurate in predicting malignancy, and if used as a sole predictive sign, it has a relatively poor specificity (49%) and positive predictive value (40%).^[8]

Margins and Outline

A malignant thyroid nodule tends to have ill-defined

margins on ultrasound.^[8] A thyroid nodule is considered ill-defined when more than 50% of its border is not clearly demarcated. The reported sensitivity of ill-defined margins and irregular margins, however, ranges widely (53% to 89% and 7% to 97%, respectively). The specificity of ill-defined margins is variable, with 15%-59% of benign nodules having poorly defined margins with macro or micro-lobulations.^[9]

The halo or hypoechoic rim around a thyroid nodule is produced by a pseudo-capsule of fibrous connective tissue, compressed thyroid parenchyma, and chronic inflammatory infiltrates. A completely uniform halo around a nodule is highly suggestive of benignity, with a specificity of 95% [Figure 1A,B]. However, a halo is absent at the US in more than half of all benign thyroid nodules.^[9] The absence of a halo has a specificity of 77% and a sensitivity of 67% in predicting malignancy.^[8]

Shape

Nodules that are larger in the anteroposterior dimension than in the transverse dimension (i.e. taller than wider) have a higher risk of being malignant. This may be due to the centrifugal growth of the tumor against tissue planes as occurs in the breast.^[9] [Figure 2]

Calcification

Thyroid calcifications can be classified as micro-calcification, coarse calcification, or peripheral calcification. Thyroid micro-calcifications are psammoma bodies, which are round laminar crystalline calcific deposits.^[9] Coarse, dysmorphic or curvilinear calcifications commonly indicate benignity.^[8] Studies assessing calcification on ultrasound as a risk for malignancy have focused on micro-calcifications and it appears that while the presence of microcalcifications is generally not a very sensitive predictor of malignancy it is relatively specific (75 – 95%) for identifying a malignant nodule. [Figure 3A]

Vascularity or color flow pattern

In general, there are three patterns of vascular distribution within a thyroid nodule.

Type I: the complete absence of flow signal within the nodule [Figure 4]

Type II: exclusive perinodular flow signals

Type III: intramodular flow with multiple vascular channels randomly arranged, with or without significant perinodular vessels.

Type III pattern is generally associated with malignancy [Figure 3B]. Types I and II are more commonly seen in benign hyperplastic nodules.^[8] However, vascularity is not a specific sign of thyroid malignancy. Frates et al showed that more than 50% of hypervascular solid thyroid lesions were benign.^[10]

Consistency

It is generally believed that thyroid nodules with a large cystic component are usually benign. However, papillary carcinoma occasionally demonstrates a cystic component and may mimic a benign nodule, though the presence of punctate calcification within the solid component helps in

its identification.^[8]

Local Invasion

Direct tumor invasion of adjacent soft tissue and metastases to lymph nodes are highly specific signs of thyroid malignancy. The extra-capsular extension has been demonstrated in 36% of thyroid malignancies.^[9] It occurs more frequently in medullary carcinoma (50% cases) than papillary carcinoma (40% cases).^[7]

Lymph node Metastases

Metastases to regional cervical lymph nodes have been reported to occur in 19.4% of all thyroid malignancies.^[11] US features of lymph node metastases include a rounded bulging shape, increased size, replaced fatty hilum, irregular margins, heterogeneous echo-texture, calcifications, cystic areas, and vascularity throughout the lymph node instead of normal central hilar vessels at Doppler imaging.^[7] (case8)

Multinodular

The multiplicity of the nodule is not an indicator of benignity. The incidence of malignancy is same in solitary nodules as it is in multiple nodules. Interval growth of nodules is a non-specific characteristic.^[7]

Size

Recent studies show that the size of the nodule has no bearing on the rate of malignancy. In a study by Papini et al,^[18] there was no difference in cancer rates within nodules 8 – 10 mm and 11 – 15 mm. Similarly Yassa et al,^[12] also found no difference in cancer rates in nodules between 1cm and greater than 3cm. A study from Seoul found there is a higher rate of malignancy in the smaller nodules.^[13]

Hence no ultrasound sign is both sensitive and specific for the prediction of malignancy. From the evidence reviewed here, solidity and hypo echogenicities are sensitive signs and microcalcifications, irregular margins and taller shape are more specific signs. It is well recognized that the predictive ability of ultrasound for malignancy is effective only when multiple signs [Table 1] are present in the same nodule. The predictive value increases in summation, at the cost of sensitivity.^[14]

Aims and Objectives

- To evaluate the diagnostic accuracy of ultrasound criteria for the depiction of a benign and malignant thyroid nodule.
- To correlate the findings with FNAC / Biopsy.

Subjects and Methods

A prospective Study included 50 patients referred to the Department of Radio-diagnosis at Dayanand Medical College and Hospital, Ludhiana for an ultrasound of neck or thyroid with clinical suspicion of thyroid lesion. Clinical history regarding the onset of symptoms and the progression of the disease was taken. All the patients were subjected to ultrasound on Phillips IU22 ultrasound machine using a high-frequency linear-array transducer (7-15 MHz) that provides adequate penetration and high-

resolution image. Scanning was done both in the transverse and longitudinal plane using both gray-scale and color Doppler techniques. The imaging characteristics of a mass (viz. location, size, shape, margins, echogenicity, consistency, calcification, contents and vascular pattern) was identified. The nodule was classified as hypoechoic if the echogenicity was less than that of the thyroid parenchyma. Fine needle aspiration cytology (FNAC) or biopsy was suggested to confirm the diagnosis. The US diagnosis was compared to tissue diagnosis.

Results

A total of 50 patients were included in the study. Majority of the patients, 40(80%) were in 31 to 60 years of age group, youngest being 19 years old and the eldest being 69 years old. The mean age was 47.4 years. 44(88%) females and 6(12%) males were included in the present study. The male to female ratio was 1:7.3. The malignancy rate was found to be higher in females (10 out of 13, 76.9%). Papillary carcinoma of the thyroid was the most common malignant lesion. The only case of thyroid lymphoma in our study was also found in a 65-year-old female patient. The most common presenting symptom was swelling in the neck (44 cases, 88%) either diffuse or localized followed by neck pain and cough.

In our study, most of the lesions were solid (62%) and only 12% of the lesions were cystic in consistency. All the cystic and majority of the mixed consistency lesions turned out to be benign on pathological analysis. 12 out of 13 (92%) malignant lesions were solid and only 1 lesion was of mixed consistency on the US. The majority (6 out of 7) of the cases which turned out to be thyroiditis in the final

diagnosis, was solid in consistency.

The maximum number of lesions in our study were reported to be hypoechoic on the US, followed by hyperechoic and anechoic echo-pattern. And only 2 lesions were reported as isoechoic. All the malignant lesions (100%) on final diagnosis were hypoechoic on the US. Although, 33.3% of the hypoechoic lesions were found to be benign on pathological analysis. Benign lesions consisted of all the echo-patterns with the majority (14 out of 30) being hyperechoic on the US.

Well defined margins were found in most (68%) of the lesions and ill-defined margins in 22% of the lesions. Margins were not assessed in 10% of the cases as no focal lesion was identified in them on the US. Most (79.4%) of the lesions with well-defined margins on the US were benign in nature with only 14.7% being malignant and 5.9% being thyroiditis. Majority of the malignant lesions (8 out of 13, 61.5%) had ill-defined margins on the US and 38.5% (5 out of 13) lesions had well-defined margins. Margins could not be assessed in 5 cases as no focal lesion was identified in them on US. [Table 2]

Micro-calcifications were reported in 20% of the patients in the US. No calcification was identified in the majority of cases (62%).

Presence of micro-calcification is considered as an important predictor of malignancy. It was observed that 90% of cases with micro-calcification on the US, were found to be malignant and only 1 case which turned out to be benign colloid goiter as final diagnosis, had micro-calcification. The majority (88.9%) of the cases with macro-calcification were benign. However, one case of anaplastic carcinoma showed macro-calcification within it.

Table 1: US Features suggestive of Benign or Malignant thyroid nodule

Benign	Malignant
Iso or Hyperechoic	Hypoechoic
Coarse calcifications	Micro-Calcifications
Thin well defined halo	Thick, irregular or absent halo
Regular margin	Irregular margin
Lack of invasion	Invasive growth
Low or absent intranodular flow	High intranodular flow
No regional lymphadenopathy	Regional lymphadenopathy

Table 2: Comparison of margins of the lesion with the pathological outcome

		CYTO/HISTOPATHOLOGY						Total	
		Benign		Malignant		Thyroiditis			
		No.	% Age	No.	% Age	No.	% Age	No.	% Age
Margins	Well-defined	27	79.4%	5	14.7%	2	5.9%	34	100.0%
	Ill-defined	2	18.2%	8	72.7%	1	9.1%	11	100.0%
	Not Applicable	1	20.0%	0	0.0%	4	80.0%	5	100.0%
Total		30	60.0%	13	26.0%	7	14.0%	50	100.0%

Table 3: Comparison of pattern of vascularity on color doppler with the pathological outcome

		CYTO/HISTOPATHOLOGY						Total	
		Benign		Malignant		Thyroiditis			
		No.	% Age	No.	% Age	No.	% Age	No.	% Age
Vascularity	Peripheral	8	72.7%	1	9.1%	2	18.2%	11	100.0%
	Internal	8	34.8%	11	47.8%	4	17.4%	23	100.0%
	No significant vascularity	14	87.5%	1	6.3%	1	6.3%	16	100.0%
Total		30	60.0%	13	26.0%	7	14.0%	50	100.0%

Table 4: Comparison of shape of the lesion on US with the pathological outcome.

		CYTO/HISTOPATHOLOGY						Total	
		Benign		Malignant		Thyroiditis			
		No.	% Age	No.	% Age	No.	% Age	No.	% Age
Shape Taller Than Wider	Yes	3	27.3%	7	63.6%	1	9.1%	11	100.0%
	No	26	76.5%	6	17.6%	2	5.9%	34	100.0%
	Na	1	20.0%	0	0.0%	4	80.0%	5	100.0%
Total		30	60.0%	13	26.0%	7	14.0%	50	100.0%

Table 5: Diagnostic index and criteria of individual US feature for predicting malignancy in thyroid lesions

US feature	True positive	False positive	True negative	False negative
Solid consistency	12	19	1	18
Hypochoic echo-pattern	13	17	0	20
Ill-defined margins	8	3	5	34
Micro-calcifications	10	1	3	36
Taller than wider shape	7	4	6	33
Internal vascularity	11	12	2	25

Table 6: Predictive value of all the US features to suggest malignancy in a thyroid lesion

US feature	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Chi-square Value	p-value
Solid	92.3	48.6	38.7	94.7	6.849	0.009
Hypochoic	100	54.5	43.3	100	8.488	0.004
Ill-defined margins	61.5	91.9	72.7	87.1	16.004	0.000
Micro-calcification	69.3	97.3	90.0	90.0	30.882	0.000
Taller than wider	53.8	89.1	63.4	84.6	10.383	0.001
Internal vascularity	84.6	67.5	47.8	92.5	10.546	0.001

Table 7: Comparison between US and pathological diagnosis

		CYTO/HISTOPATHOLOGY			Total
		Benign	Malignant	Thyroiditis	
US	Benign	28	1	2	31
	Malignant	1	12	0	13
	Thyroiditis	1	0	5	6
Total		30	13	7	50

Table 8: Predictive values of the US features in our study when used in various combinations

US features	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
HE + MI	69.3	97.3	90.0	90.0
HE + IVS	76.9	81.0	58.8	90.0
HE + ID	61.5	91.9	72.7	87.1
MI + IVS	61.5	100	100	88.1
MI + ID	46.1	100	100	84.1
ID + IVS	53.8	97.3	87.5	85.7
HE + MI + IVS	61.5	100	100	88.1
HE + MI + IVS + ID	38.5	100	100	82.2
HE + MI + IVS + ID + TTW	23.1	100	100	78.7

HE: Hypochoic, MI: Micro-calcification, IVS: Internal vascularity, ID: Ill-defined margins, TTW: Taller than wider

Table 9: Comparison of the predictive values of combined US features with few studies in literature.

US features	Author & year of study	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
HE + MI	Rago14 1998	30.0	79.7	26.4	73.7
	Peccin25 2002	31.0	97.0	71.0	85.0
	Present study	69.3	97.3	90.0	90.0
HE + IVS	Rago14 1998	44.0	70.2	38.8	76.4
	Present study	76.9	81.0	58.8	90.0
MI + IVS	Rago14 1998	23.3	86.4	41.1	73.5
	Present study	61.5	100	100	88.1
HE + MI + IVS	Rago14 1998	20.0	89.1	42.8	73.3
	Present study	61.5	100	100	88.1

HE: Hypochoic, MI: Micro-calcification, IVS: Internal vascularity, ID: Ill-defined margins

The majority (46%) of the lesions showed internal vascularity on US color Doppler. No significant vascularity could be demonstrated in 32% of the lesions. 11 out of 13 (84.6%) malignant lesions had internal vascularity on color Doppler. In contrast, only 8 out of 30 (26%) lesions reported as benign on final diagnosis had evidence of

internal vascularity. Most (46.6%) of the benign lesions showed no significant vascularity and 26% were found to have a peripheral pattern of vascularity on color Doppler. [Table3]

11 (22%) lesions were reported to be taller than wider, 34(68%) lesions were not taller than wider and this feature

was not assessed in 5 (10%) cases as no focal lesion was identified. It was observed that 63.6% (7 out of 11) of the lesions which were reported to be taller than wider in shape on the US turned out to be malignant. 4 cases with taller than wider shape on the US were not malignant in nature. [Table4]

Six ultrasound predictors (consistency, echogenicity, margins, calcification, shape, vascularity) for malignancy were evaluated in our study. Solid consistency and hypoechoic patterns are sensitive signs and ill-defined margins, micro-calcification and taller than wider shape is more specific signs of malignancy. [Table 5,6]

On the US, 31(62%) cases were reported as benign, 13(26%) as malignant and 6(12%) were reported as thyroiditis.US accurately diagnosed 90.3% (28 out of 31) of the benign cases, 92.3% (12 out of 13) of the malignant and 83.3% (5 out of 6) cases of thyroiditis, while only 10% (5 out of 50) of the total cases (50) were inaccurately assessed. [Table7]

The overall sensitivity, specificity, and PPV of ultrasound in identifying a benign lesion in our study was 93.3, 85.0 and 90.3% respectively. The overall sensitivity, specificity and PPV of US in identifying a malignant lesion in our study was 92.31%, 97.30%, and 92.31% respectively.

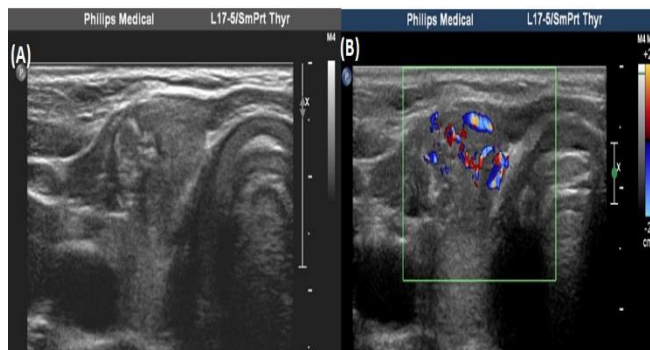


Figure 3A,B: Grey scale (Fig. A) and Color doppler (Fig. B) images show a well-defined solid hypoechoic nodule with microcalcification and internal vascularity. Ultrasound diagnosis was malignant nodule on histopathology came out to be papillary carcinoma thyroid

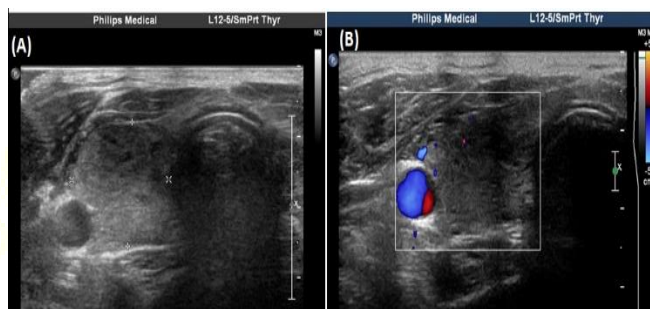


Figure 4: Transverse US image show bulky right (Fig. A) lobe of thyroid and heterogeneously hypoechoic pattern. Color doppler image (Fig. B) shows no significant vascularity specific for benign thyroid nodule.

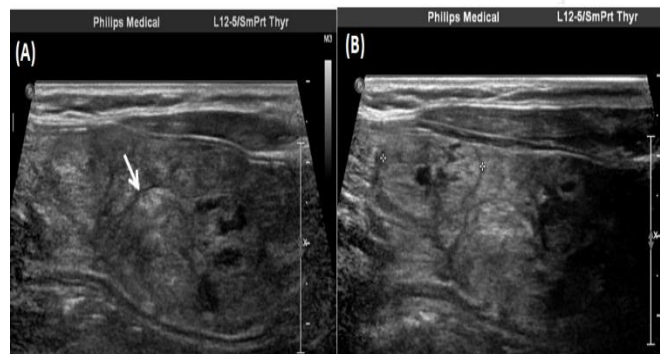


Figure 1A,B: Longitudinal US images showing bulky right (Fig. A) & left (Fig. B) lobes of thyroid and heterogeneously hypoechoic pattern with solid hyperechoic nodules seen within them. Note the hypoechoic halo around the nodule in Fig. A marked with an arrow.



Figure 2: Transverse US images show a hypoechoic solid lesion which is taller than wider, in the right lobe of thyroid diagnostic of malignant thyroid nodule. Histopathological came out to be medullary carcinoma of thyroid

Discussion

A number of ultrasound features have been identified over the last 15-20 years which assist in predicting the risk of malignancy in a thyroid lesion. These include solid consistency, hypoechoic echo-pattern, micro-calcification, taller than wider shape, ill-defined margins and internal vascularity. The overall sensitivity reported for any one suspicious ultrasound feature is 83 – 93%. [15,11,16]

The prevalence of thyroid lesions either benign or malignant is more in women than in men. [7,4,10,17] This was also reflected in our study as 88% of patients were females and 12% were male. In our study, the majority of the patients were between 31-60 years of age, similar to a study conducted by Vander et al, [18] in 1968. In our study, 74% (37) lesions were benign, and 26% (13) of the lesions turned out to be malignant.

As compared to the previous studies in the literature, [19] the rate of malignancy was higher in our study. The reason could be that our hospital being tertiary care and a referral center, number of patients with clinical suspicion of malignancy are referred to us for further management.

We found that 92.3% of the malignant lesions were solid in consistency, all the cystic and majority of the mixed lesions were benign. In a paper by Koike (2001), reported that 81.8% of all the malignant nodules were completely

solid,^[20] and in 2007, a Korean study of 1036 patients demonstrated that 98.4% of papillary cancers and 82.6% of follicular cancers were solid.^[21] In a study from Boston, it was found that completely cystic lesions were never malignant and the malignancy rate decreased as the nodule became more cystic with 14.3% malignancy rate in solid lesions, 10.3% in mainly solid lesions, 5.7% in mixed lesions and 2.3% in cystic nodules.^[10]

In 2002 Kim et al,^[15] found that while most solid thyroid nodules were hypoechoic compared to the rest of the thyroid gland, malignant nodules tended to be markedly hypoechoic. This can be correlated to our study, as all of our malignant lesions were hypoechoic on sonography with a sensitivity of 100% and specificity of 54.05% closely related to study by Papini et al (2002),^[11] Cappelli et al (2006),^[22] Gulcelik et al (2008),^[23] There is a wide range of sensitivity and specificity for hypo-echogenicity as a predictor of malignancy. This may in part be due to the fact that there is no uniform definition for “hypoechoic”. Some authors use the background thyroid as a comparison and others the strap muscles.

Presence of micro-calcification in a thyroid lesion is an important predictor of malignancy with high specificity. It turned out to be a highly specific sign for malignancy as studied by Ragoet al,^[14] Cappelli et al,^[22] Hong et al.^[24]

The sensitivity and specificity for shape i.e. taller than wider in our study was 53.8% and 89.1% respectively in 2002, Kim et al found that, taller than wider shape had a low sensitivity (32.7%) but a high specificity (92.5%) for predicting malignancy.^[15]

Taking margins of a lesion into consideration, 8 of the 13 malignant lesions had ill-defined margins and only 3 benign cases had ill-defined margins. A low sensitivity (61.5%) and high specificity (91.9%) was noted in detecting a malignant lesion when ill-defined margins were taken into consideration. This is similar to the studies documented in the literature by Papini et al,^[11] Kim et al,^[15] Hong et al,^[24] as the sensitivity for this feature is generally low with higher specificity.

Of all the US signs for predicting malignancy, vascularity remains the most contested. Internal vascularity had a sensitivity of 84.6% and specificity of 67.5% in detecting a malignant lesion. In comparison, low sensitivities and specificities are reported in most studies. Many studies do not report this feature at all. Sensitivities range from 62 – 74% and specificities from 48 – 70%.^[22,14,11] In 2010 Moon et al designed a large study to look specifically at the predictive value of vascularity and found that it did not add any information to grey scale ultrasound.^[16]

Features which favored a benign etiology included cystic consistency, hyperechoic echo-pattern, macro or no calcification, wider than taller shape, well-defined margins and peripheral pattern of vascularity.

It is widely recognized that any single sonographic feature cannot be considered specific for malignancy. The presence of any one suspicious ultrasound feature is a highly sensitive predictor for a malignant nodule ranging from 83 – 93%.^[15,11,16] No US feature has both high sensitivity and a high positive predictive value for thyroid cancer. The sensitivities, specificities, and negative and positive

predictive values of these features are extremely variable from study to study, which may be the result of a large number of residents and trainees performing ultrasounds, because of lack of a standardized reporting format was the case in our study also.

From the results shown in [Table 8], it is clearly interpreted that when the features are used in combination, the specificity and positive predictive value of ultrasound in diagnosing a malignant lesion increases significantly as sighted in most of the studies in the literature.^[22,14,10] The combination of hypoechoic echo-pattern and micro-calcification was the most sensitive and specific of all the features.

The combination of various ultrasound features as a predictor of malignancy is highly specific, as evident by the results of our study and as documented by most of the previous studies in the literature.^[22,14,10] [Table 9]

In a study by Eisuke Koike et al, the sensitivity and specificity of US in the detection of malignancy was 81.8% and 91% respectively.^[20] In another study conducted by Dhanadia et al,^[26] in Gujarat, India, the sensitivity and specificity of ultrasound in detecting a malignant lesion was 83.3% and 72.7% respectively. In a recent study done by Tyagi et al,^[27] in 2016 in Uttar Pradesh, India, for detection of malignancy by the US, the sensitivity came out to be 80% with specificity and PPV of 100%. In our study, the sensitivity, specificity, and PPV of US in identifying a malignant lesion was 92.31%, 97.30%, and 92.31% respectively.

Conclusion

To summarise, Ultrasound is valuable for identifying many malignant or potentially malignant thyroid nodules. The ultrasound features favouring a malignant lesion included – solid consistency (Sn 92.3%; Sp 48.6%; p=.009), hypoechoic echo-pattern (Sn 100%; Sp 54.5%; p=.004), micro-calcification (Sn 69.3%; Sp 97.3%; p=.000), taller than wider shape (Sn 53.8%; Sp 89.1%; p=.001), ill-defined margins (Sn 61.5%; Sp 91.9%; p=.000) and internal vascularity (Sn 84.6%; Sp 67.5%; p=.001). A single feature is not pathognomonic of malignancy. However, in combination, these features assisted in diagnosing malignant lesion. Features that favored a benign etiology included cystic consistency, hyperechoic echo-pattern, macro or no calcification, wider than taller shape, well-defined margins and peripheral pattern of vascularity. The overall sensitivity, specificity, and PPV of ultrasound in identifying a malignant lesion was 92.31%, 97.30%, and 92.31% respectively. It is non-invasive, safe, fast, cost effective and can be repeated a number of times. Hence ultrasound is very sensitive and specific imaging modality for identifying and characterizing a thyroid lesion as benign or malignant.

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