Section: Radiology

Original Research Article

COMPARISON AND EVALUATION OF GRAYSCALE ULTRASOUND AND COLOR DOPPLER FINDINGS OF THYROID NODULES WITH FINE NEEDLE ASPIRATION CYTOLOGY FINDINGS

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ABSTRACT

Background: The thyroid gland is a large endocrine gland and superficial location of the thyroid gland helps in excellent visualization and also helps in the evaluation of its normal anatomy, normal anatomical variants and pathological conditions by high resolution real-time grey-scale sonography.
Objective: To compare and evaluate of Grayscale and Color Doppler Findings of thyroid nodule with Fine Needle Aspiration Cytology Findings.
Materials and Methods: This is a prospective study on conducted 50 patients with thyroid swelling over a period of 18 months. The study was conducted within the age group of 10 to 80 years including both the gender.
Results: Presence of gray scale features - Taller- than-wide shape, Lobulated/poorly defined margins, Hypoechogenicity and Marked hypoechogenicity, Thick incomplete /absent halo, Microcalcifications, Central/ central > peripheral pattern of vascularity and associated cervical lymphadenopathy suggests malignancy. Likewise the presence of Wider than tall shape, Well defined margins, Hyperechogenicity, and Thin halo suggests benignity. A solid/ predominantly solid component alone cannot be a useful criterion for the differentiation of malignant from benign nodules. The presence of calcification or macrocalcification showed no statistical significance in the differentiation of a malignant nodule from a benign nodule. Using a 5-category US classification system, the specificity and positive predictive value were high for distinguishing benign and malignant nodules. But the diagnostic accuracy did not cross 75% for any of the ultrasound categories. However the overall diagnostic accuracy of thyroid US for differentiating a malignant lesion from a benign one in the present study was found to be 84.3 % which is in correlation with previous studies.
Conclusion: Ultrasound and Colour Doppler study is an easy, non-invasive and rapid technique that can be routinely used as an additional tool in the work-up of thyroid nodules to select cases for FNAC, avoid unnecessary biopsies, and consequently decrease the hazards and costs. It also increases confidence in the decision for benign versus malignant when assessing thyroid nodules.
Keywords: Ultrasound, Colour Doppler, thyroid nodules, FNAC.

INTRODUCTION

Thyroid nodules are very common in the general population, and their detection is increasing with the widespread use of high resolution ultrasound. Ultrasound is beneficial not only in differentiating benign from malignant nodules but also in guiding procedures like fine-needle aspiration cytology. Of all the cases of thyroid nodule studies have proven that 5-15% are malignant.[1]

Thyroid nodules are common occurring in up to 50% of the adults and higher in females as compared to males. High-resolution ultrasonography (US) is commonly used to evaluate the thyroid gland, but US is frequently misperceived as unhelpful for identifying features that distinguish benign from malignant nodules.

In ultrasonography (US), 10%–67% of adults have thyroid nodules. Thyroid US has been widely used to differentiate benign from malignant nodules and to guide fine- needle aspiration cytology for nodules suspected of being malignant.

A combination of the US findings provides better diagnostic accuracy than only one of these findings. However, considerable overlap between benign and malignant characteristics has been found in results of some studies. Sensitivity and specificity of the US findings for malignant thyroid nodules are also variable.

On imaging, significant relationship was observed between malignancy and lesion characteristics like hypoechogenicity, irregular margins, taller than wide, thick incomplete halo, micro calcifications, lymph node enlargement and local infiltration.[2] Compared to individual characteristics a combination of the ultrasound findings provides better diagnostic accuracy. Fine-needle aspiration cytology is considered a sensitive, specific and accurate diagnostic test in the evaluation of patients with thyroid swellings.

The US-FNAC, a high TIRADS score, and clinical features such as hard in consistency and significant lymph nodes are significant in predicting malignancy in thyroid nodule ≥1 cm.[3]

MATERIALS AND METHODS

This Prospective Study was conducted in the Department of Radio-diagnosis and Department of Pathology in Khaja Bandanawaz Institute of Medical Sciences, Kalaburagi. Duration of The Study: wass 18 months (November 2019 - April 2021).

RESULTS

In the present study, patients of age group 10-80 years were included, with overall mean age being 43.91 ± 13.8 years. Mean age in Benign and Malignant was 41.17 ± 12.98 and 53.64 ± 13.4 years respectively. The maximum number of patients belonged to 5th decade of life (34%) followed by 4th decade (26%). Female sex was affected more compared to the male sex (84% females and 16% males).

Right lobe of thyroid was the most common location for both benign (55.55%) and malignant (85.71 %) thyroid nodules.

Table 1: Shape of thyroid nodule

SHAPE OF NODULE	FNAC (No. of Cases and Percentage)				
	BENIGN	MALIGNANT	TOTAL	Odd's (95% CI)	P Value
WIDER THAN TALL	34 (94.45%)	4 (28.57%)	38 (76%)	51 (8.259-314.931)	<.0001(HS)
TALLER THAN WIDE	2 (5.55%)	10 (71.43%)	12 (24%)		
Total	36 (100.00%)	14 (100.00%)	50 (100.00%)		

Out of 50 cases, 39 (78%) were of size more than 2 cm in diameter, of which 30 (83.33%) were benign nodules and 9 (64.29%) were malignant nodules.

Wider than tall (Fig 3) was more frequently seen in benign thyroid nodule 34 out of 36 cases (94.45%) whereas Taller-than-wide (Fig 4) seen in 10 malignant cases (73.1%). Classification based on shape characteristic was found to be statistically significant.

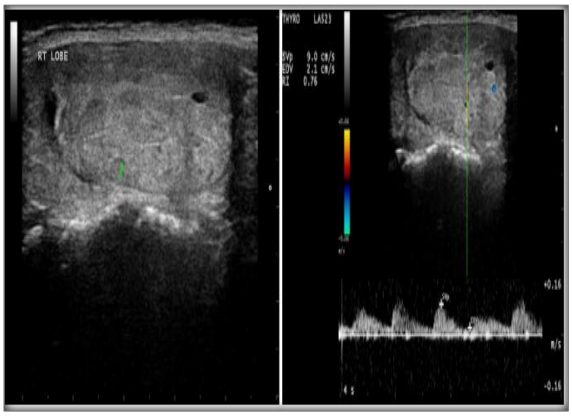
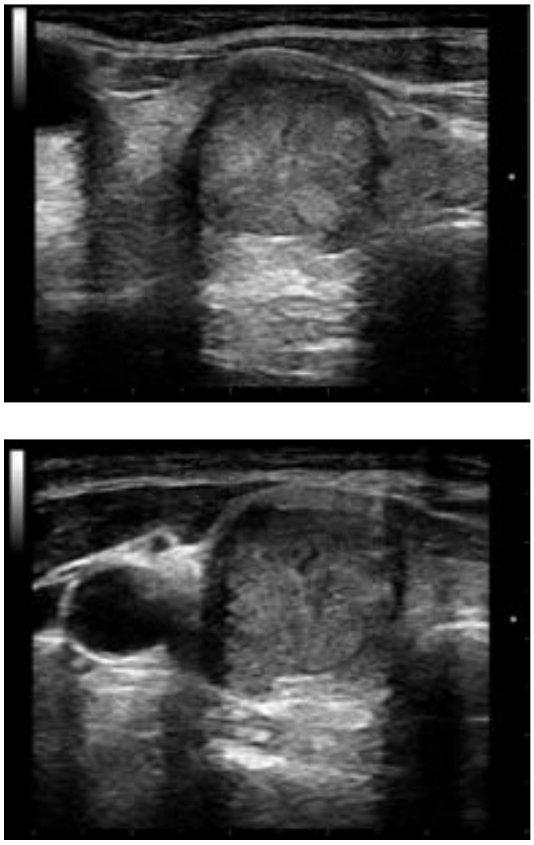
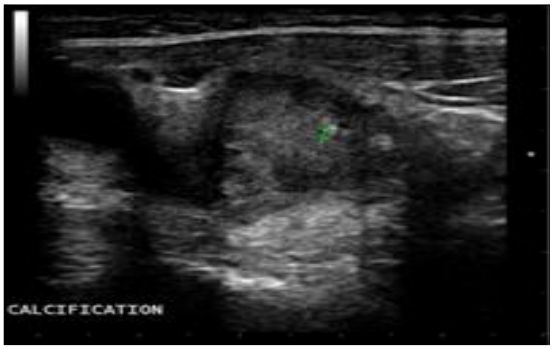


Figure 3: Longitudinal images showing a well-defined wider than tall ovoid shaped solid nodule in right lobe of the thyroid with hypoechoic halo, biopsy proved it to represent a hyperplastic nodule





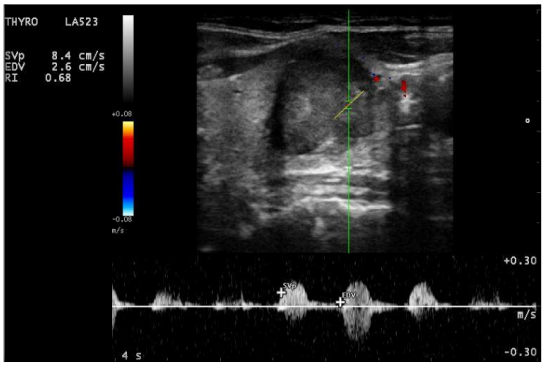


Figure 4: Longitudinal and transverse gray-scale images shows a taller than wide, lobulated isoechoic nodule with hypoechoic areas in the left lobe. The nodule has a thick incomplete halo with speck of calcification within. On color Doppler, central vascularity was noted with an RI of 0.68. HPR proved to be follicular carcinoma

Table 2: Margins of thyroid nodule

MARGINS	FNAC (No. of Cases and Percentage)				
	BENIGN	MALIGNANT	TOTAL	Odd's (95% CI)	P Value
Well Defined	34 (94.45%)	2 (14.29%)	36 (71.40%)	102 (12.9027 - 806.3459)	< .0001(HS)
Lobulated/ Poorly Defined	2 (5.55%)	12 (85.71%)	14 (28.60%)		
Total	36 (100.00%)	14 (100.00%)	50 (100.00%)		

Well Defined margins was more frequently seen in benign category (94.45%) and Lobulated/Poorly Defined margins (Fig 5) was more frequently seen in malignant category (85.71%). Classification based on Margins was found to be statistically significant.

Out of 50 cases, Cystic composition was predominantly seen in benign nodules (21 cases out of 36) whereas Solid Composition was mainly seen in malignant nodules (13 out of 14 cases). This finding was found to be statistically significant (<0.05).

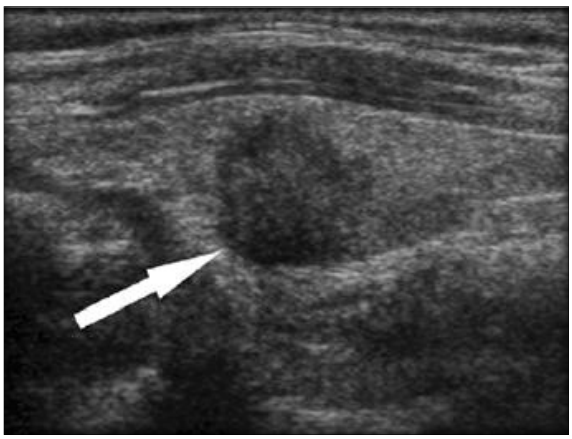


Figure 5: Longitudinal image of hypoechoic papillary cancer (arrow) with irregular margins. The lesion is larger in anteroposterior dimension than in craniocaudal dimension (taller than wide)

Table 3: Echotexture of thyroid nodule

ECHOTEXTURE	BENIGN	MALIGNANT	TOTAL
HYPERECHOIC	20 (55.55%)	01 (7.14%)	23 (46%)
HYPOECHOIC	04 (11.11%)	08 (57.14%)	11 (22%)
MARKEDLY			
HYPOECHOIC	0	04 (28.57%)	4 (8%)
ISOECHOIC	02 (5.56%)	01 (7.14%)	3 (6%)
ANECHOIC	10 (27.78%)	0	9 (18%)
TOTAL	36	14	50

Hypoechogenicity and Marked hypoechogenicity were seen to occur more frequently in malignant category (12 cases) than in benign category (4 cases) whereas hyperechogenecity was seen more frequently in benign category (20 cases) than in malignant category (1 case). Anechoic shadows were seen only in benign nodules (10 cases).

Table 4: Halo of thyroid nodule

HALO	FNAC (No. of Cases and Percentage)				
	BENIGN	MALIGNANT	TOTAL	Odd's (95% CI)	P Value
	31	2	33		<
Thin	(86.11%)	(14.29%)	(66.00%)	37.2000	.0001(HS)
Thick					
Incomplete	5	12	17	(6.3359 -	
/ Absent	(13.89%)	(85.71%)	(34.00%)	218.4128)	
	36	14	50		
Total	(100.00%)	(100.00%)	(100.00%)		

Thin halo (Fig 6) was seen in 31 out of 36 benign nodules (86%) whereas thick incomplete/Absent halo was more frequently seen in malignant nodules, 12 out of 14 cases (88.5%). Classification based on Halo was found to be statistically significant.

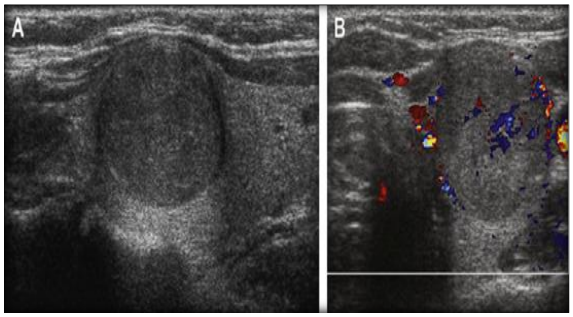


Figure 6: Follicular adenoma. (A) Longitudinal gray-scale image shows well-defined hypoechoic nodule with incomplete halo. (B) Transverse image shows flow in peripheral hypoechoic capsule and internally

27 out of 36 cases (75%) and 9 out of 14 cases (64.29%) in benign and malignant nodules respectively showed no calcifications. Macro calcifications (Fig 7.) were the predominant type in both benign and malignant nodules (12 out of 50 cases). However, this finding was not statistically significant (0.423).

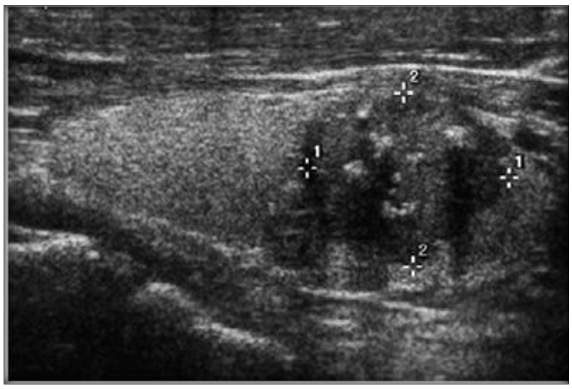


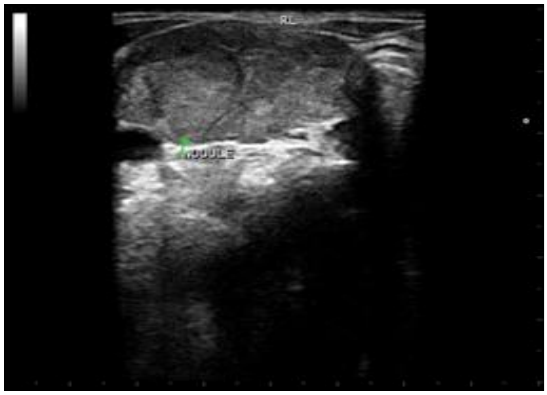
Figure 7: Medullary carcinoma. Longitudinal image shows hypoechoic nodule at inferior pole of thyroid with coarse central calcifications

Table 5: Patterns of calcifications in thyroid nodule

CALCIFICATIONS	FNAC (No. of Cases and Percentage)				
	BENIGN	MALIGNANT	TOTAL	Odd's (95% CI)	P Value
MACRO	9 (25.00%)	3 (21.43%)	12 (24.00%)	7.33 (-15.52 to 30.19)	0.423 (NS)
MICRO		2	2		
	0	(14.28%)	(4.00%)		
ABSENT	27	9	36		
	(75.00%)	(64.29%)	(72.00%)		
	36	14	50		
Total	(100.00%)	(100.00%)	(100.00%)		

Table 6: Pattern of vascularity in thyroid nodule

PATTERN	FNAC (No. of Cases and Percentage)				
	BENIGN	MALIGNANT	Total	Odd's (95% CI)	P Value
				15,1905	
AB / Peri /	29	3	32	(3.3216-	
Peri > Cen	(80.56%)	(21.43%)	(64.00%)	69.4689)	.0005(HS)
Cent >	7	11	18		
Peri	(19.44%)	(78.56%)	(36.00%)		
	36	14	50		
Total	(100.00%)	(100.00%)	(100.00%)		



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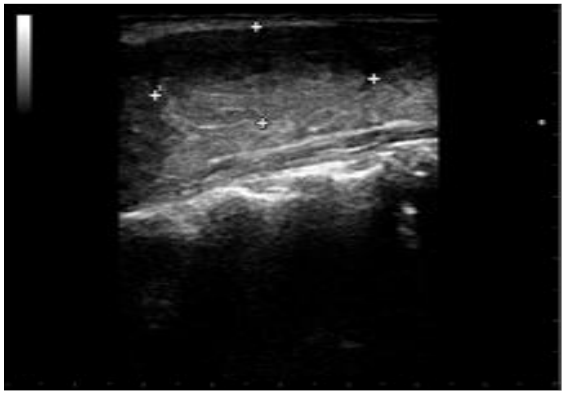

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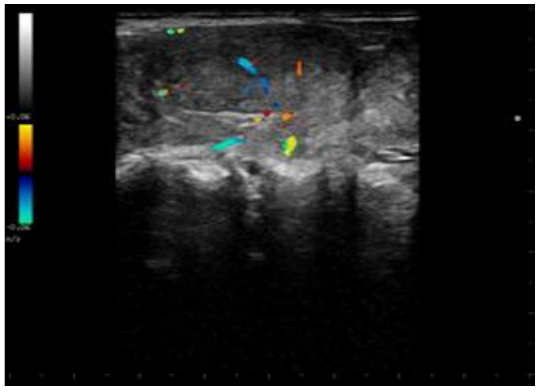

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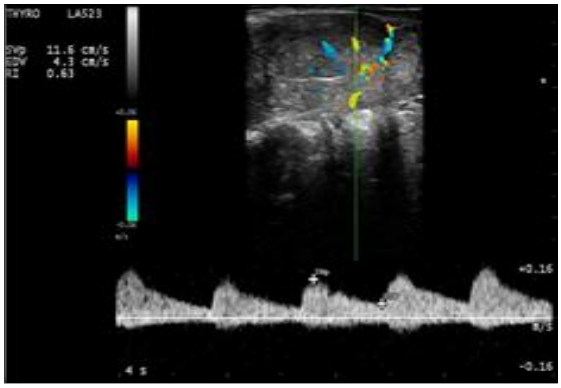

Figure 8: Longitudinal images showing hypoechoic nodule in the right lobe of thyroid with specks of calcifications. Color Doppler images showing central vascularity with an RI of 0.63. Histopathological examination proved it to be medullary carcinoma of thyroid

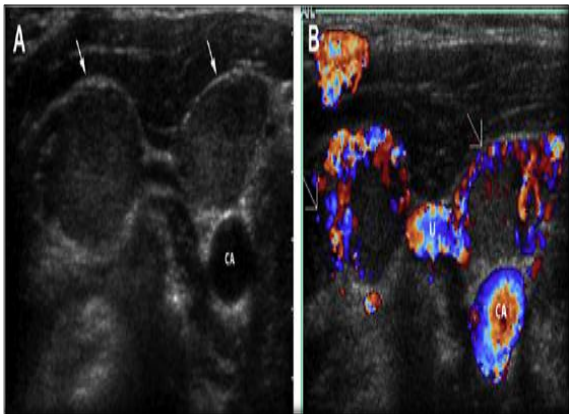

Figure 9: Metastatic nodes with rounded shape. (A) Transverse view of the right lateral cervical chain shows two abnormal lymph nodes (arrows) that are rounded without a visible echogenic hilum. (B) Both nodes show marked peripheral vascularity on color Doppler examination.

Table 7: Association of cervical lymphadenopathy with thyroid nodule

LYMPH NODES	FNAC (No. of Cases and Percentage)				
	BENIGN	MALIGNANT	TOTAL	Odd's (95% CI)	P Value
PRESENT	2 (5.55%)	5 (35.71%)	7 (14.00%)	0.1059 (0.0176	0.0143(S)

ABSENT	34 (94.44%)	9 (64.29%)	43 (86.00%)	-0.6386)	
Total	36 (100.00%)	14 (100.00%)	50 (100.00%)		

Cervical lymphadenopathy was seen in only 7 cases out of 50. It is more frequently seen in malignant nodules (35.71%) (Fig 9) than in benign category (5.55%). Classification based on association of cervical lymphadenopathy was found to be statistically significant.

Table 8: Distribution of thyroid lesions diagnosed on ultrasonography

USG DIAGNOSIS	NUMBER	PERCENTAGE
COLLOID CYST	9	18%
HEMORRHAGIC CYST	1	2%
ADENOMATOID NODULE	20	40%
FOLLICULAR ADENOMA	6	12%
PAPILLARY CARCINOMA	9	18%
FOLLICULAR CARCINOMA	4	8%
MEDULLARY CARCINOMA	1	2%

Most common lesion that was diagnosed on USG was Adenomatoid nodule in 40 % of the patients followed by colloid cyst and papillary carcinoma in 18% of the patients. The remaining lesions were follicular adenoma (12%), follicular carcinoma (8%) medullary carcinoma (2%), and hemorrhagic cyst (2%).

Table 9: Distribution of thyroid lesions based on FNAC diagnosis

USG DIAGNOSIS	NUMBER	PERCENTAGE
COLLOID CYST	9	18%
HEMORRHAGIC CYST	1	2%
COLLOID /ADENOMATOID NODULE	20	40%
FOLLICULAR ADENOMA	6	12%
PAPILLARY CARCINOMA	9	18%
FOLLICULAR CARCINOMA	4	8%
MEDULLARY CARCINOMA	1	2%

In the Benign group, colloid /adenomatoid nodule was the most common (n =20) followed by colloid cyst (09). Diagnoses of malignancy included papillary thyroid carcinoma (n = 09) followed by follicular carcinoma (n = 04) and medullary thyroid carcinoma (n = 02).

Table 10: Matching of ultrasound diagnosis with FNAC diagnosis

USG DIAGNOSIS	NUMBER	PERCENTAGE
COLLOID CYST	9	18%
HEMORRHAGIC CYST	1	2%
COLLOID /ADENOMATOID NODULE	20	40%
FOLLICULAR ADENOMA	6	12%
PAPILLARY CARCINOMA	9	18%
FOLLICULAR CARCINOMA	4	8%
MEDULLARY CARCINOMA	1	2%

Matching of ultrasound diagnosis with FNAC diagnosis was seen in 40 % of the cases of Adenomatoid nodule, 18% each of colloid cyst and papillary carcinoma, 12 % of Follicular adenoma cases, 8 % Follicular carcinoma and 2 % each of medullary and hemorrmagic cyst cases.

On comparison with USG diagnosis and FNAC, the positive predictive value to detect colloid cyst by ultrasound was 94.2% in this study. In this study ultrasound is 88.9% sensitivity and 72% specificity in detecting colloid cyst. And the positive predictive value for detecting medullary carcinoma was 100% and papillary carcinoma was 94.2%. Ultrasound has 86.6% positive predictive value for adenomatous nodule. Ultrasound has 85% sensitivity and 75% specificity in detecting follicular carcinoma.

The US features of Taller-than-wide, Lobulated/poorly defined margins, Hypoechogenicity and Marked hypoechogenicity, Thick incomplete /absent Halo, Microcalcifications, Central/ central > peripheral pattern of vascularity and associated cervical lymphadenopathy were more frequently seen in malignant nodules than benign and were individually statistically significant for depiction of a malignant nodule.

The US features of Wider than tall, well defined margins, Hyperechogenicity, and Thin halo were more frequently seen in benign than malignant nodules and were individually statistically significant for depiction of a benign nodule.

The US finding of solid /predominantly solid nodule was found almost in equal incidence in benign and malignant groups and was not statistically significant.

The presence of calcifications was more in benign nodules. Macro calcifications also occurred more

frequently in the benign nodules, but were found not statistically significant.

DISCUSSION

Of 50 nodules, 36 were benign and 14 were malignant. Right lobe of thyroid was the most common location for both benign and malignant thyroid nodules, 20 out of 36 and 12 out of 14 respectively. Of the 36 benign nodules, 30 were more than 2 cm in diameter and of the 14 malignant nodules, 9 were more than 2 cm in diameter

In the benign group, colloid/ adenomatoid nodule was the most common (n =20) followed by colloid cyst (09) and follicular adenoma (06). Diagnoses of malignancy included papillary thyroid carcinoma (n= 9) followed by follicular carcinoma (n = 4) and medullary thyroid carcinoma (n = 1).

On analyzing the Ultrasound features, features such as Taller-than-wide, Lobulated/poorly defined margins, Hypoechogenicity and Marked hypoechogenicity, Thick incomplete /absent halo, Microcalcifications, Central/ central > Peripheral pattern of Vascularity and associated cervical lymphadenopathy were individually statistically significant for depiction of a malignant nodule. This correlated well with the study done by Moon et al,[4] who found that Taller than wide shape, A speculated margin, Marked hypoechogenicity, Hypoechogenicity, and presence of microcalcification as features statistically significant for the depiction of a malignant nodule.

The shape of the nodule has been studied as a marker of malignancy. The width of the nodule on a transverse scan corresponds to the natural growth planes. Malignant tumors have a tendency for centrifugal growth and show expansion perpendicular to the natural growth plane. The appearance at USG is of a nodule that is taller than wide (i.e., anteroposterior diameter > transverse diameter on transverse scan). In 2006, Cappelli et al. in their series concluded that a taller-than wide shape was a useful criterion for identifying a malignant lesion.[5] Popowicz et al. indicated hypoechogenicity, the presence of microcalcifications, and the shape (with height-to-width ratio >1) to be independent features suggestive of malignant lesions, irrespective of their size.[6] In the present study, we measured the anteroposterior (AP) and transverse (T) diameters and found AP≥T to have a moderately high specificity and sensitivity.

The US features of Wider than tall, Well defined margins, and Thin halo were individually statistically significant for depiction of a benign nodule. This again correlated well with the study of Moon et al4 who found that Wider than tall and Well defined margins are significant to depict benignity. However present study found that hyperechogenicity to be significantly associated with benignity, which is in contradiction to the study of Moon et al.

Composition of the nodule was found to be statistically significant in the present study and this correlated well with the study of Moon et al.[4]

The US finding of solid /predominantly solid nodule was found almost in equal incidence in benign and malignant groups and was not statistically significant. Moon et al,[4] found microcalcification to be statistically significant in prediction of malignancy, but it was not found to be significant in the present study.

In the present study, presence of any of these features - taller than-wide shape, lobulated/poorly defined margins, marked hypoechogenicity and microcalcification was very specific in the range of 94% - 100%. These findings are comparable to studies done by Popli et al,[7] who found specificity range of 80.1% - 97.9% and that of Moon et al,[4] in which it ranged 90.8% - 92.8%.

When the presence of any of the above malignant findings was chosen as a criterion for malignancy, the overall accuracy ranged 76% - 92%. This correlated well with study done by Popli et al,[7] in which diagnostic accuracy ranged 79.5%-92%.

Solid/predominantly solid composition of the nodule with thick incomplete or absent halo had a high sensitivity in the range of 85.7% - 92%. These findings are comparable to study done by Popli et al,[7] who found sensitivity range of 70.4% -88.6%.

On comparison with USG diagnosis and FNAC, the positive predictive value t detect colloid cyst by ultrasound was 92.5% in this study. Yeh et al,[8] showed that micronodulation on sonography is useful for diagnosing colloid cyst because of a high positive predictive value which was 94.2%. Venkatachalapathy et al,[9] found that the overall sensitivity for FNAC in their series was 81.3% for benign lesions. In this study ultrasound was 88.9% sensitivity and 72% specificity in detecting colloid cyst. Features considered in this study were heterogenous thyroid parenchyma with increased vascularity and micronodulations.

The positive predictive value for detecting medullary carcinoma was 100% and for papillary carcinoma it was 94.2%. Ultrasound has 85% positive predictive value for adenomatous nodule.

Chaudhary et al,[10] has stated in his study that the overall sensitivity of thyroid ultrasound for diagnosing a malignant nodule is 83.3%. In this study it was identified that ultrasound has 80% sensitivity and 75% specificity in detecting malignant nodules based on the sonographic findings.

CONCLUSION

Ultrasound and Colour Doppler study is an easy, non-invasive and rapid technique that can be routinely used as an additional tool in the work-up of thyroid nodules to select cases for FNAC, avoid

unnecessary biopsies, and consequently decrease the hazards and costs. It also increases confidence in the decision for benign versus malignant when assessing thyroid nodules.

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