Original Article

Study of correlation of sonographic findings with that of pathological findings in differentiating benign from malignant thyroid lesions

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Abstract

Introduction: Thyroid gland or simply, thyroid in vertebrate anatomy is one of the largest endocrine glands. It is the first endocrine gland to appear in the fetus and is the only one which is amenable to direct physical examination because of its superficial location. **Aims and Objectives:** To Study of correlation of sonographic findings with that of pathological findings in differentiating benign from malignant thyroid lesions **Materials and methods:** Data for the study was collected from all the patients of clinically suspected thyroid diseases, who are referred for thyroid ultrasound to Department of Radiodiagnosis, attached to GMC and General Hospital, Latur. Study was done for a period of 2 years, from October 2011 to September 2013.Chi square test, percentage and proportions were used wherever applicable. EPI INFO version 3.5.1 software was used for data analysis. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy were determined **Result:** The statistically significant features in differentiating malignant and benign pathologies are ill defined margins; heterogeneous echotexture; hypoechogenicity and calcification. A sensitivity greater than 65% are shown by heterogeneous echotexture (73.34%), ill-defined margins (73.34%), hypoechogenicity (73.34%) and internal flow pattern (66.67%). Highest specificity shown by microcalcification 97.87% although it shows the lowest sensitivity-54.54%, followed by ill-defined margins. A positive prediction value of 75% is shown by presence of microcalcification followed by ill-defined margins- 73.34%. **Conclusion:** USG has become the first-line imaging modality for evaluation of the thyroid gland, and has largely supplanted scintigraphy for thyroid evaluation due to excellent visualization of thyroid parenchyma, its high sensitivity in detection of small nodules, calcifications, andseptationsand cyst formation

Keywords: Thyroid lesions, hypoechogenicity, micro-calcification.

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INTRODUCTION

Thyroid gland or simply, thyroid in vertebrate anatomy is one of the largest endocrine glands. It is the first endocrine gland to appear in the fetus and is the only one which is amenable to direct physical examination because of its superficial location. The thyroid gland controls how quickly body uses energy, makes proteins, and controls how sensitive the body is to other hormones. It is one of the major secreting organ, the secretion being generated by its own auto regulatory mechanism. Any factor causing discrepancy in the autoregulatory function results in spectrum of thyroid function disorders. Thyroid disorders are the most common among all the endocrine diseases in India as well as in world.[1] In a large population study (in Framingham, Massachusetts), clinically apparent thyroid nodules were present in 6.4% of women and 1.5% of men.[2] Knowledge of the prevalence of thyroid disorders in general population is based on clinical epidemiological studies and autopsy series. Iodine deficiency is one of the important causes of thyroid disorders. India is in transition phase from iodine deficiency to iodine sufficiency, and this is expected to

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change thyroid status of the population. The thyroid status and autoimmune status of population is largely unknown.[3] The clinical spectrum of thyroid diseases range from simple benign nodule to malignancy. So it is essential to have proper imaging tools to evaluate the thyroid gland. Before the advent of high resolution ultrasound capability, radionuclidescintigraphy was the chief means to evaluate the thyroid gland both functionally and morphologically. High-resolution US is the most sensitive test available to detect thyroid lesions, measure their dimensions accurately, identify their structure, and evaluate diffuse changes in the thyroid gland. Along with being much safer and non- ionizing, ultrasound is also a much cheaper alternative. C.T. and M.R.I are used in the evaluation of thyroid masses, but are not as sensitive as ultrasound in the evaluation of intrathyroidal lesions but are used in the evaluation of mediastinal extension of thyroid masses. Thyroid ultrasound is best prevalence indicator for the assessment iodine deficiency disorders.[4] Thyroid ultrasound differentiates solid from cystic lesions, solitary nodules from multiple and diffuse enlargement, and extrathyroidal lesions. Nearly 50% of clinically solitary thyroid nodules patients avoided surgery by ultrasound scanning. The newly developed high resolution ultrasonography with color Doppler flow mapping can provide fine details of thyroid gland and hemodynamic features of thyroid neoplasms.[5]

MATERIALS AND METHODS

Data for the study was collected from all the patients of clinically suspected thyroid diseases, who are referred for thyroid ultrasound to Department of Radiodiagnosis, attached to GMC and General Hospital, Latur. Study was done for a period of 2 years, from October 2011 to September 2013. Patients referred for the thyroid ultrasound scan were included in study if following inclusion criteria is met: Patients with nodular or diffuse swellings of thyroid, Patients with clinical suspicion of thyroid dysfunction, Patients with cervical lymphadenopathy suspicious of thyroid malignancy. Patients with swellings in neck other than thyroid swellings, Patients with cervical lymphadenopathy or clinical suspicion of thyroid dysfunction who found to have normal thyroids on ultrasonography, Patients with history of bleeding disorders, Patient not willing for examination were excluded from the study Present study was a prospective, diagnostic study which included 120 patients meeting the inclusion criteria. Sonoscape ultrasound machine equipped with linear probe with frequency of 7.41 MHZ which is mainly used for examination of thyroid region. Chi square test, percentage and proportions were used wherever applicable. EPI INFO version 3.5.1 software was used for data analysis. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy were determined wherever applicable using following formulae: Sensitivity $= \frac{A}{A+C}$, Specificity $= \frac{D}{B+D}$, Positive predictive value $= \frac{A}{A+B}$ Negative predictive value $= \frac{D}{C+D}$, Accuracy $= \frac{A+D}{A+B+C+D}$, Where, A= true positives, B= false positives, C= false negatives and D= true negatives.

RESULT

Table 1: Frequency analysis of Ultrasonographic characteristics of benign and Malignant thyroid lesions

Characteristic (Ultrasonographic)	Pathological Findings			p value
	Benign (n=94)	Suspicious (n=11)	Malignant (n=15)	
Internal content				-
Purely cystic	9 (9.57%)	0 (0%)	0 (0%)	
Cystic with thin septa	5 (5.31%)	2 (18.19%)	1 (6.67%)	
Solid	59 (62.76%)	6 (54.55%)	12 (80%)	
Solid and cystic	21 (22.34%)	3 (27.27%)	2 (13.34%)	
Margin				**<0.05**
Well defined	90 (95.75%)	4 (36.36%)	4 (26.67%)	
Ill defined	4 (4.26%)	7 (63.64%)	11 (73.33%)	
Echotexture				**<0.05**
Homogeneous	83 (88.30)	5 (45.45%)	4 (26.67%)	
Heterogeneous	11 (11.70%)	6 (54.55%)	11 (73.33%)	
Echogenicity				**<0.05**
Hyperechoic	42 (44.68%)	2(18.19%)	1 (6.67%)	
Hypoechoic	22 (23.4%)	5 (45.45%)	11 (73.33%)	
Isoechoic	30 (31.91%)	4 (36.36%)	3 (20%)	
Calcification				**<0.05**
Macrocalcification	1 (1.06%)	0	0	
Microcalcification	2 (2.12%)	2 (18.19%)	6 (40%)	

Egg shell calcification	1 (1.06%)	2 (18.19%)	0	
Halo				-
Thin	65 (69.15%)	1 (9.09%)	2 (13.33%)	
Thick	2 (2.12%)	2 (18.19%)	3 (20%)	
Regular	65 (69.15%)	3 (27.28%)	2 (13.33%)	
Irregular	2 (2.12%)	0	3 (20%)	
Complete	64 (68.08%)	2 (18.19%)	3 (20%)	
Incomplete	3 (3.19%)	1 (9.09%)	2 (13.33%)	

This chart depicts the statistical significance of various ultrasonographic features in differentiating between benign and malignant lesions. The statistically significant features in differentiating malignant and benign pathologies are ill defined margins; heterogeneous echotexture; hypoechogenicity and calcification.

Table 2: Diagnostic performance of ultrasound findings for malignant lesions (Excluding suspicious results)

Characteristic	Sensitivity	Specificity	NPV%	PPV%
Heterogeneous echotexture	73.34% (11/15)	88.3% (83/94)	95.4% (83/87)	50% (11/22)
Ill-defined margins	73.34% (11/15)	95.75% (90/94)	95.75% (90/94)	73.34% (11/15)
Hypoechogenicity	73.34% (11/15)	76.6% (72/94)	94.73% (72/76)	33.34% (11/33)
Microcalcification	54.54% (6/15)	97.87% (92/94)	91.08% (92/101)	75% (6/8)
Internal flow pattern	66.67% (10/15)	76.6% (72/94)	93.67% (74/79)	33.34% (10/30)

This analytic chart depicts the sensitivity, specificity, negative predictive value and positive predictive value of ultrasound findings for various features which are characteristic of malignant lesions. A sensitivity greater than 65% are shown by heterogeneous echotexture (73.34%), ill defined margins (73.34%), hypoechogenicity (73.34%) and internal flow pattern (66.67%). Highest specificity shown by microcalcification 97.87% although it shows the lowest sensitivity-54.54%, followed by ill defined margins. A positive prediction value of 75% is shown by presence of microcalcification followed by ill-defined margins-73.34%.

DISCUSSION

Correlation of Echotexture with cytopathology: Our study suggests that malignant lesions are mostly heterogeneous. Lu C, Chang TC, *et al*[6](1994) also noted similar observations.

Correlation of Echogenicity with cytopathology

In this study hypoechoic pattern was more commonly seen in malignant than in benign lesions thus making it an important ultrasound feature for suspecting malignancy. Sensitivity, specificity and positive predictive value for the diagnosis of malignancy is 73.34%, 76.6% and 33.34% (for the hypoechogenicity alone) respectively.Solbiati*et al*[7] (1985) observed the solid hypoechoic pattern in 63 % of malignant. Leenhardt*et al*[8] (1994) reported the positive predictive value of 50% to 63% for hypoechogenicity alone in cases of malignancy. Nam-Goong*et al*[9] (2004) reported 68.2% sensitivity, 52.9% specificity and 27% positive predictive value for hypoechogenicity alone in diagnosis of malignancy. The results of present study are comparable to this. Hence it can be concluded that thyroid malignancies tend to be hypoechoic when compared with the rest of the thyroid. Since most benign thyroid lesions, which are far more common than malignancies, are also hypoechoic, this finding is not particularly useful except that it is reasonably safe to conclude that hyperechoic lesions are probably not cancerous.

Correlation of internal content (nature) of lesion with cytopathology:

In present study, it was found that all purely cystic lesions were found to be benign on cytopathology. Mixed nature (solid and cystic) of lesions was observed in 13.34% of carcinomas and 22.34% of benign lesions, thus finding of cystic change in a lesion is an unreliable sign for differentiating benign from malignant. However, we further observed that cystic change is seen in only 6.67% of malignancies. Solbiati *et al*[7] (1985) also observed the negligible rate of malignancy in cystic and hyperechoic nodules, 3 out of 139 malignancies had hyperechoic pattern and none of the cystic nodule was malignant. These findings are comparable to our study. Watters *et al*[10] (1992) also reported negligible rate of malignancy in nodule showing more than 50% of cystic change. Thus, it was concluded that if any thyroid lesion showed cystic change of 50 % or more then it was more likely a benign nodule. In this study 66.67 % of the lesions were solid, as compared to 75% by Solbiati *et al*[7](1985). Of the 64 solid lesions, 59 (73.75%) were benign and 12 (15%) were malignant ($p<0.05$). Of the 15 malignant lesions 12 were solid (80%) and of the 94 benign lesions 59 (62.76%) were solid. Hence solid component was observed in majority of benign as well as malignant nodules. These findings are consistent with the findings of Moon W. J. *et al*[11] (2008). Therefore, a predominantly solid component alone cannot be useful criteria for the differentiation of malignant from benign nodules.

Correlation of Calcification with cytopathology

In this study it was found that calcifications are uncommon (11.67%) overall. However, it was seen in higher percentage of malignant lesions (6 out of 15, 40%) compared to benign lesions (4 out of 94, 4.25%). Watters *et al*[10] (1992) found calcifications in 37% of the malignant lesions. This is comparable to present study. In a study conducted by Jenny K. Hoang*et al*[12] (2007) showed that microcalcifications are one of the most specific ultrasound findings of a thyroid malignancy. The lower detection rate for calcifications may be due to the use of 7.41 MHz frequency probe as the highest frequency available for the study. Kim *et al*[13] (2002) reported that sonography is not highly sensitive in revealing microcalcifications unless they occur within masses. For the better correlation of calcification with malignancy, the pattern of calcification was further subdivided into fine (micro), coarse (macro) and eggshell calcification. When present, it was found that microcalcification was associated with higher percentage of malignant lesions (6 out of 10, 60%) than benign lesions (2 out of 10, 20%). The sensitivity, specificity and positive predictive value of microcalcification for the diagnosis of malignancy is 54.54%, 97.87% and 75% respectively.Solbiati*et al*[14] (1992) reported sensitivity of 59.3%, specificity of 95.2% diagnostic accuracy of 83.8% of microcalcifications for diagnosis of thyroid cancer. The results of present study are comparable to this. Takashima *et al*[15] (1995) showed the specificity of 93% and positive predictive value of 70%.

Correlation of hypoechogenicperilesional halo with cytopathology

Halo was observed in a total of 75 (62.5%) cases. Of the 94 benign lesions 67 (71.27%) showed halo. Out of 11 suspicious lesions 3(27.27%) showed halo. Of the 15 malignant nodules 5 (33.34%) showed halo. These findings are almost similar to the findings of Solbiati *et al*[29] (1985) who observed that the halo was more frequently observed in benign than in malignant abnormalities (86% vs. 14%). When present thin, complete and regular halo was observed in significant percentage of benign lesions 97%, 97%, 95.5% respectively.Whereas thick and irregular halo was observed in malignant lesions.

Correlation of lesion margins on ultrasonography with cytopathology

In this study, Out of the 94 benign lesions 90 (95.75%) showed well defined margins and 4 (4.25%) showed ill defined margins. Of the 15 malignant lesions 11(73.34%) showed ill defined margins and 4 (26.67%) showed well defined margins. It is clear from the observations that a higher percentage of the malignant lesions showed ill defined margins whereas most of the benign lesions showed well defined margins. The findings are similar to the findings observed by Kovacevic *et al*[16] (2007) who reported 72% of malignant nodules to be showing ill defined, irregular margins.

Correlation of vascularity with cytopathology

In this study peripheral vascularity was observed in a higher percentage of benign lesions 52/94 (55.31%) followed by internal flow pattern in 20/94 (21.28%). Diffuse increased vascularity was observed in 20 lesions, most of them (85%) are benign. In malignant lesions internal vascular pattern was observed in a higher percentage of lesions 10/15 (66.67%). The most common pattern of vascularity in thyroid malignancy is marked internal vascularity, which is defined as flow in the central part of the tumour that is greater than that in the surrounding thyroid parenchyma. The sensitivity, specificity and positive predictive value of internal flow pattern for the diagnosis of malignancy are 66.67%, 76.6% and 33.34% respectively. Papini *et al*[17] (2002) defined an intranodular vascular pattern on colour Doppler ultrasound as most suspicious, with sensitivity of 74.2% and specificity of 80.8%. The results of present study are similar to their results. However, it is not a specific sign of thyroid malignancy. Frates *et al*[18] (2003) showed that hypervascular solid thyroid lesions have higher risk of malignancy.

Table 1: Diagnostic accuracy of ultrasound findings for malignancies

Characteristic	Sensitivity	Specificity	PPV
Heterogeneous echotexture	73.34% (11/15)	88.3% (83/94)	50% (11/22)
Ill defined margins	73.34% (11/15)	95.75% (90/94)	73.34% (11/15)
Hypoechogenicity	73.34% (11/15)	76.6% (72/94)	33.34% (11/33)
microcalcification	54.54% (6/15)	97.87% (92/94)	75% (6/8)
Internal flow pattern	66.67% (10/15)	76.6% (72/94)	33.34% (10/30)

The features that have a high specificity for malignancy are ill defined margins, presence of microcalcifications and heterogeneous echotexture. High sensitivity for malignancy is shown by hypoechogenicity, internal flow pattern and heterogeneous echotexture. This is similar to the conclusions made by various other studies by Watters *et al*[10] (1992), Kovacevic *et al*[16] (2007) and Moon *et al*[11] (2008).

CONCLUSION

USG has become the first-line imaging modality for evaluation of the thyroid gland, and has largely supplanted scintigraphy for thyroid evaluation due to excellent visualization of thyroid parenchyma, its high sensitivity in detection of small nodules, calcifications, andseptationsand cyst formation

REFERENCES

1. Kochupillai N. Clinical endocrinology in India.Current Science. 2000 Oct; 79(8):1061.
2. Vander JB, Gaston EA, Dawber TR. The significance of nontoxic thyroid nodules: final report of a 15-year study of the incidence of thyroid malignancy. Ann Intern Med. 1968; 69:537-540.
3. UshaMenon, Sundaran JR: High prevalence of undetected thyroid disorders in iodine sufficient adult south Indian population. Journal of Indian MedicalAssoc, 2009 Feb; 107(2): 72-7.
4. Brahmbhatt S, Brahmbhatt MR, Boyages SC. Thyroid ultrasound is the best prevalence indicator for assessment of iodine deficiency disorders : a study in rural/tribal school children from Gujarat (Western India). European Journal of Endocrinology.2000; 143:37-46.
5. Taylor KJW, Carpenter DA *et al*: Gray scale ultrasonography in the diagnosis of thyroid swellings. Journal Of Clinical Ultrasound 2005; 2(4):327-330.
6. Lu C, Chang TC, Hsiao YL, Kuo MS. Ultrasonographic findings of papillary thyroid carcinoma and their relation to pathologic changes. J Formos Med Assoc, 1994 Nov-Dec; 93(11-12):933-8.
7. Solbiati L, Volterrani L, Rizzatto G, *et al*. The thyroid gland with low uptake lesions: evaluation by ultrasound. Radiology.1985; 155:187-191.
8. Leenhardt L, Tramalloni J, Aurengo H, Delbot T, Guillausseau C, Aurengo A. Echography of thyroid nodules: the echography specialist facing the clinician's requirements. Presse Med. 1994; 23:1389-1392.
9. Nam-Goong IS, Kim HY, Gong G, *et al*. Ultrasonography guided fine-needle aspiration of thyroid incidentaloma: correlation with pathological findings. ClinEndocrinol (Oxf) 2004; 60(1): 21-8.
10. Watters DA, Ahuja AT, Evans RM, *et al*. Role of ultrasound in the management of thyroid nodules. Am J Surg. 1992; 164:654-657.
11. Moon W J, So Lyung Jung, Jeong Hyun Lee, Dong Gyu Na, Jung-Hwan Baek, Young Hen Lee,*et al*. Benign and Malignant Thyroid Nodules: US Differentiation - Multicenter Retrospective Study. Radiology: 2008; 247(3), 762-770.
12. Jenny K Hoang, W K Lee, *et al*. US features of thyroid malignancy: Pearls and Pitfalls. Radiographics 2007; 27(3): 847-860.
13. Kim EK, Park CS, Chung WY, *et al*. New sonographic criteria for recommending fine-needle aspiration biopsy of nonpalpable solid nodules of the thyroid. AJR Am J Roentgenol. 2002; 178:687-691.
14. Solbiati L, Cioffi V, Ballarati E. Ultrasonography of the neck. RadiolClin North Am. 1992; 30:941-953.
15. Takashima S, Fukuda, Nomura N, Kishimoto H, Kim T, Kobayashi T. Thyroid nodules:re-evaluation with ultrasound.JClin Ultrasound.1995;23:179 84.
16. *ObadKovacevic* and Mirna Smetana Skurla.Sonographic diagnosis of thyroid nodules: Correlation with the results of sonographically guided fine-needle aspiration biopsy. Journal of Clinical Ultrasound. 2007; 35(2): 63-67.
17. *Papini E, Guglielmi R, Bianchini A, et al. Risk of malignancy in nonpalpable thyroid nodules: predictive value of ultrasound and color-Doppler features. J ClinEndocrinolMetab. 2002; 87(5): 1941-6.*
18. Frates Mary C, Carol B. Benson, Peter M. Doubilet, Edmund S. Cibas, Ellen Marqusee. Can Color Doppler Sonography Aid in the Prediction of Malignancy of Thyroid Nodules? J Ultrasound Med 22:127-131, 2003.

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