ORIGINAL ARTICLE

Diagnostic validity of ultrasonography in thyroid nodules

Nanik Ram,[1] Saima Hafeez,[2] Saqib Qamar,[3] Syed Zubair Hussain,[4] Ali Asghar,[5] Zahid Anwar,[6] Najmul Islam[7]

Abstract

Objective: To determine the diagnostic validity of thyroid ultrasound in differentiating between benign and malignant thyroid nodules.

Methods: The cross-sectional study was conducted at Aga Khan University Hospital, Karachi, from August 2011 to January 2013, and comprised all patients of either gender with thyroid nodules referred for ultrasound thyroid and fine needle aspiration cytology. Ultrasonography was performed by radiologists and ultrasound parameters were assessed and compared with cytology results in all nodules. Diagnostic validity of each ultrasound feature was calculated.

Results: Of the 101 patients, 81(80%) were female. The overall mean age was 43±13 years (range: 15-73 years). On histocytopathology, 96(95%) nodules were benign and 5(4.9%) were malignant. The sensitivity and specificity of ultrasound features in predicting malignancy were calcification 80% and 68%; hypoechogenecity 80% and 52%; ill-defined lobulated margin 40% and 96%; solid 80% and 40%; taller than wider 50% and 63%. Each ultrasound feature had negative predictive value ranging from 95% to 98% in malignant nodules.

Conclusion: Identification of calcification, hypoechogenecity and solid with ill-defined margins in a thyroid nodule on ultrasound was helpful in suspecting thyroid malignancy and warranted urgent diagnostic fine needle aspiration cytology.

Keywords: Thyroid nodule, Ultrasonography, Validity. (JPMA 65: 875; 2015)

Introduction

Thyroid nodules are common and present in about 5% of the population[1,2] and up to 50% of thyroid nodules are found incidentally at autopsy.[3] Most of these nodules are benign and approximately 5-9% of thyroid nodules are malignant on histopathology examination.[1-5] With increased use of imaging, ultrasound has detected small thyroid nodules in 60-70% of the population.[4,5] Thyroid cancer risk is equal in both palpable and non-palpable thyroid nodules.[6-9]

A thyroid ultrasound scan is recommended in the evaluation of any suspected thyroid nodule detected clinically or by imaging.[10,11] Ultrasound of the thyroid helps in determining the anatomy of the gland, the number, characteristics and malignant potential of thyroid nodules, as well as presence of adjacent cervical lymphadenopathy. Once suspicious findings are present, it warrants urgent ultrasound-guided fine needle aspiration cytology (FNAC) of these nodules or lymph nodes.

A number of studies have assessed the ability of specific characteristics of thyroid nodules on ultrasound to distinguish between malignant and benign nodules.[12-21] Ultrasound features that have been found to be consistently associated with an increased risk of malignancy include a predominantly solid lesion, hypoechogenecity, calcification, irregular margins and absence of halo, a tall thin nodule, intranodular vascularity, invasion of extrathyroidal structures and abnormal lymph nodes.

One study reported that the combination of a solid, hypoechoic nodule with at least one of microcalcification, blurred margins or intranodular vascularity would identify 87% of thyroid cancers.[16] Absence of combinations of suspicious ultrasound features in thyroid nodule is associated with negative predictive value (NPV) >98%, indicating a low risk (<2%) of malignancy in these nodules.[16,21] Ultrasonography of thyroid nodule does help in differentiating between benign and malignant nodule.

The current study was planned to determine the diagnostic validity of thyroid ultrasound in differentiating between benign and malignant thyroid nodules.

Patients and Methods

The cross-sectional study was conducted at Aga Khan University Hospital (AKUH), Karachi, from August 2011 to January 2013, after approval was obtained from the institutional ethical review Committee.

All Patients of either gender with thyroid nodules referred for ultrasound thyroid and FNAC were included. Patients with known thyroid malignancy, pure cystic lesion, and indeterminate, non-diagnostic, suspicious finding in cytology without subsequent surgery were excluded.

[1,4,7]Section of Endocrinology, Department of Medicine, [2,3,6]Department of Radiology, Aga Khan University Hospital, [5]Department of Endocrinology, Liaquat National Hospital and Medical College, Karachi.

Correspondence: Nanik Ram. Email: nanikkhatwani@yahoo.com

Ultrasonography was performed by radiologists (Toshiba US; models Zario and Nemio). High frequency linear probe with 7.5 MHz bandwidth was used. Ultrasound images of all nodules were evaluated by two radiologists with 2 and 8 years of experience blindly and reached a consensus by discussion. The ultrasound parameters assessed in all nodules were: Nodule size — taller or wider (maximum diameter as evaluated by sagittal and transverse scans); echographic structure (Solid, Mixed or Cystic); echogenicity (Iso-, Hyper- or Hypoechoic); margins (Regular, Irregular); presence/absence of calcification; vascular pattern (along the maximum diameter of the nodule); Type 0 (absence of flow signals); Type 1 (vascular images in peripheral position); Type 2 (intranodular flow with multiple vascular images).

According to ultrasonographic criteria, nodules were labelled as benign when none of the suspicious finding presents, including microcalficafication, irregular margins, hypoechogenisity, grade II intranodular vascularity and shape taller than wider.

Radiologist performed ultrasound-guided FNAC, using 23-guage needle attached to a 20-ml disposable plastic syringe and aspirator with free-hand techniques. The FNAC was attempted twice for each nodule. In mixed (solid/cystic) nodule, ultrasound features and FNAC was done from solid portion of the nodule.

Cytological specimens were smeared according to the Papanicolaou technique by experienced cytopathologists. When the smear was inadequate (<6 clusters with <10 cells each), FNAC was repeated once. The cytological reports were categorised as malignant, benign, suspicious for thyroid carcinoma, indeterminate (follicular or Hurthle cell neoplasm), and non-diagnostic. The ultrasound parameters were compared with FNAC or histopathology (in operated nodules) results.

Clinical, ultrasonographic, cytological, and histological findings were separately recorded and blind-processed for statistical evaluation. All analyses were conducted using SPSS 19. All p-values were two-sided and considered statistically significant if <0.05. Means and standard deviations (SDs) were given for continuous data, while frequencies and percentages were given for categorical data. Diagnostic validity of thyroid ultrasound in benign and malignant thyroid nodule was calculated by 2x2 tables at each level. Sensitivity, specificity, PPV and NPV were calculated.

Results

During the study period, 215 thyroid ultrasound had been done of which 101(47%) comprised the study population. The mean age of patients was 43±13 years (range: 15-73 years) and 81(80%) were females. Overall, 96(95%) nodules were benign and 5(4.9%) were malignant on histocytopathology.

Table-1: Ultrasound findings of 101 benign and malignant nodules.

Ultrasound findings	Malignant Nodules n=5 n (%)	Benign Nodules n=96 n(%)
Presence of Calcification	4(80)	30 (31.2)
Hypoechogenecity	4(80)	46 (48)
Solid consistency	4(80)	57 (59.3)
Irregular Margins	2(40)	3 (3.1)
Grade II Vascularity	0 (0)	1 (1)
Taller than wider	2(40)	25 (26)

Table-2: Diagnostic Validity of ultrasound findings in malignant thyroid nodules.

Ultrasound Finding	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Presence of Calcification	80	68	11	98
Hypoechogenecity	80	52	8	98
Solid consistency	80	40	6	97
Irregular Margins	40	96	40	96
Grade II Vascularity	0	98	0	95
Taller than wider	50	63	7	95

PPV: Positive predictive value
NPV: Negative predictive value

Table-3: Diagnostic Validity of ultrasound findings in benign thyroid nodules.

Ultrasound Finding	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Absence of Calcification	68	80	98	11
Iso-Hyperechogenecity	52	80	98	8
Mixed-cystic consistency	40	80	97	6
Well defined Margins	96	40	96	40
Grade 0-I Vascularity	98	-	95	-

PPV: Positive predictive value
NPV: Negative predictive value

Ultrasound features with relation to histocytopathology was worked out (Table-1).

All malignant nodules were proved papillary carcinoma on histopathology at surgery.

Of the 101 nodules, 35(34.7%) showed none of the suspicious findings, 50(49.5%) showed one finding, 16(15.9%) showed two or more findings. Among the malignant nodules, 1(20%) nodule showed one finding but 4(80%) nodules had two and more suspicious findings. None of the malignant nodule revealed grade II vascularity.

Diagnostic validity of each ultrasound feature in malignant and benign thyroid nodules were separately worked out (Tables-2 and 3).

Discussion

Thyroid ultrasound is extremely important in the evaluation of

a thyroid nodule. FNAC is required only for a nodule that is suspicious. Therefore, it is very important for the radiologist to look at the individual characteristics of a thyroid nodule, and to know exactly what constitutes a nodule to be labelled as being "suspicious", which warrants an FNAC. We studied six characteristics of a thyroid nodule, namely calcification, hypoechogenecity, consistency, margins, vascularity and taller than wider shape. The objective of the study was to assess how the presence or absence of these characteristics correlate with the presence or absence of malignancy in a thyroid nodule.

With thyroid ultrasound being an operator-dependent procedure, it is very important that the radiologist identifies a suspicious nodule and performs an FNAC; yet, on the other hand, this judgment should not overshoot leading to needless FNACs. It has been shown that >99% of FNAC-proven benign thyroid nodules in 134 patients remained benign after a follow-up of 9-11 years.[22] This means that a benign thyroid nodule only rarely becomes malignant. That is why it is very important for a radiologist to identify a benign nodule so that unnecessary FNAC can be prevented.

It is well established that not all characteristics of a thyroid ultrasound have the same value in the evaluation of a thyroid nodule. Some characteristics are more sensitive while others are more specific for suspecting a malignancy. A study concluded that no single ultrasound characteristic had both high sensitivity and high specificity in pointing towards malignancy.[23] In our study, presence of calcification, hypoechogenecity and solid consistency showed a high sensitivity (80%) but relatively lower specificities. On the other hand, irregular margins and grade II vascularity had a high specificity of more than 90%.

Even with abundance of literature in this field, there is no one recommended scoring system or a defined approach, which can help the radiologist in labelling a nodule as being suspicious for malignancy. Studies have suggested an approach based on pattern recognition,[23,24] while another concluded that multiple sonographic characteristics are highly suggestive of malignancy.[13] In our study, 62% of all nodules showed at least one suspicious finding on ultrasound, although malignancy was detected in only 5% nodules. On the other hand, 80% of malignant nodules showed at least 2 suspicious characteristics on ultrasound. Absence of these characteristics make a nodule look more and more benign.

Irregular margin is a characteristic common to all malignancies, suggesting surrounding tissue infiltration by the malignant tissue. If absent, a nodule seems benign. If present, malignancy should be suspected. The American Society of Radiologists in Ultrasound noted in their consensus statement that irregular margins had a sensitivity of 17.4-77.5% and a specificity of 38.9-85.0%,[7] which depicted slightly higher specificity than sensitivity. One study showed that irregular or microlobulated margin had a sensitivity and specificity of 55.1% and 83% respectively.[25] But another study showed a lower specificity (58.9%) compared to sensitivity (72.2%), but it used a strict standard in the evaluation of irregular margins.[26] Our study showed that irregular margin was more specific than sensitive in the detection of thyroid malignancy. Absence of irregular margins in a thyroid nodule makes a case for it being benign rather than malignant.

Calcification (both micro as well as macro) may be detected in thyroid nodules. Most studies have shown calcification as being more specific than sensitive in the detection of thyroid cancer.[13,17,24-26] A study showed that calcification had a sensitivity of 88.7%.[14] Our study showed a high sensitivity (80%) and a relatively lower specificity (68%) for calcification. A thyroid nodule without calcification favours benignity rather than malignancy.

Hypoechogenecity within the thyroid nodule is considered a suspicious finding for malignancy. The American Society of Radiologists in Ultrasound showed in their consensus statement that hypoechogenecity had a sensitivity of 26.5-87.1% and a specificity of 43.4-94.3%,[7] which revealed slightly higher specificity than sensitivity. Previous studies have shown that marked hypoechogenecity has more specificity compared to hypoechogenecity.[25,26] Yet, other studies showed that hypoechogenecity is more sensitive than specific in the detection of thyroid cancer.[13,14] Our study too showed a sensitivity of 80% and a specificity of 52%. An isoechoic area within a thyroid nodule makes it look more benign than malignant.

The more solid a nodule is, the more chances there are of it being malignant. Likewise, the less solid a nodule, the more chance there is of it being benign. Pure cystic nodules are considered virtually benign. The American Society of Radiologists in Ultrasound noted in their consensus statement that solid consistency had a sensitivity of 26.5-87.1% and a specificity of 43.4-94.3%.[7] Our study revealed that solid consistency was more sensitive (80%) than specific (40%) in the detection of thyroid malignancy. A study also reported a high sensitivity for solid consistency.[14]

A wider than taller nodule (transverse dimension greater than antero-posterior dimension) favours benignity. A taller than wider nodule is more suspicious of harbouring malignancy. Studies have shown that taller than wider nodules in the breast are more likely to be malignant.[27,28] Previous researchers have demonstrated that taller than wider thyroid nodule has a high specificity compared to sensitivity in the diagnosis of thyroid cancer.[7,25,26] Our study too showed a higher specificity compared to sensitivity for this sonographic characteristic and a high negative predictive value (>90%) for

all the sonographic characteristics that we studied. On the other hand, the PPVs remained generally low. This finding is in conformity with previous studies.[7,13,25,26] Thus, a wider than taller nodule seems more benign than malignant. The results of this study can be generalised to adult Pakistani population presenting with thyroid nodule in differentiating between benign and malignant nodules.

One of the limitations of our study is that all malignant nodules were papillary thyroid cancers, so sonographic characteristics that we studied are only pertinent to papillary thyroid cancers.

Conclusion

Irregular margins and grade II vascularity were very specific, while calcification, hypoechogenecity and solid consistency were all very sensitive for suspecting thyroid cancers. No single ultrasound feature showed both high sensitivity and specificity. A combination of these sonographic characteristics should be present to label a thyroid nodule as being suspicious for malignancy, and FNAC of such nodules should be performed to diagnose thyroid cancer. On the other hand, absence of these characteristics in a thyroid nodule favours benignity and FNAC may not be needed.

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