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Vascular pattern and spectral parameters of power Doppler ultrasound as predictors of malignancy risk in thyroid nodules

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Abstract

Background: Thyroid nodules are common clinical finding by palpation. Thyroid nodule should be evaluated to exclude the presence of a thyroid malignant lesion Evaluation of the thyroid nodules are depending on history, physical examination, fine needle aspiration cytology and also imaging studies. Objective: This study was aimed to evaluate the role of spectral Doppler ultrasound parameters, including resistance index (RI) and vascular pattern in distinguishing malignant from benign thyroid nodules. **Methods:** 120 patients with thyroid nodules were selected from our patients attending Al-zahra hospital in Isfahan. We prospectively evaluated 120 thyroid nodules in patients undergoing surgery. For each nodule the flow pattern were measured by power Doppler and then ranked on a scale of 0 to 4 as follows: absent, perinodular alone, mixed with perinodular prominence, mixed with intranodular prominence and exclusively intra nodular, respectively. RI value was also recorded. Pathological examination were used as a proof of final diagnosis to categorize all nodules as benign or malignant. The data collected in check list then the data analyzed by with SPSS v21. **Results:** The mean age in patients was 45.44±14.3 years. vascularity of nodules increased the risk of malignancy of nodules and also malignant nodules had more peripheral vessels (P-value<0.001). Resistive index (RI) was significantly higher among malignant nodules (0.73 vs. 0.61; P-value<0.0001).**Conclusion:** presence of peripheral vessels pattern and RI assessed by power Doppler Ultra Sound examination could be beneficial in evaluation of thyroid nodules.

Keywords: benign, fine-needle aspiration biopsy, malignant, thyroid nodules

INTRODUCTION

Thyroid nodules are usual clinical finding by palpation. Its prevalence estimated to be from 3% to 7%. Thyroid nodule should be evaluated for exclusion of malignancy of thyroid nodules which accounts for about 5%of all thyroid nodules, independent of their size.[1,2] Increase in Incidence of thyroid cancer is faster than any other cancer that is probably because of new technical studies in screening of thyroid nodules.[3]

Evaluation of the thyroid nodules are depending on history, physical examination, fine needle aspiration cytology and also imaging studies. There are several features in thyroid B mode scan that have been indicated as potential predictors of thyroid malignancy include irregular margins, hypoechogenicity, absence of a halo, a predominantly solid composition, or presence of calcification.[4] Fine needle aspiration (FNA) biopsy is a first, simple, accurate and cost-effective method for diagnosis and assessment of thyroid nodules cytology and is now currently used as the first step in the assessment of nodular thyroid disease.[5,6] But, specimen inadequacy, sampling techniques and WHAFFT changes are problems that lead to limitation in evaluation of 2% to 28% of samples.[7-11]

Increasing of Vascularity of nodules is in association with Cellular proliferation. Power Doppler scan performed to differentiate cystic and vascular structures. Power Duplex Doppler sonography is a technique for the evaluation of the vascularity, nature of nodule and more information about those nodules which are high risk for being malignant.[12]

This study was aimed to evaluate the role of spectral Doppler ultrasound parameters, including resistance index (RI) and vascular pattern to distinguish malignant from benign thyroid nodules.

METHODS

This prospective cross sectional study was performed from March 2009 to February 2010 in Alzahra hospital, Isfahan, Iran. 120 patients with confirmed thyroid nodule were enrolled in this study. Patients were excluded if: a) multiple nodules existed on thyroid b) the FNA showed follicular adenoma or follicular carcinoma c) the pathology were permanent undetermined. The study design was approved by our ethics committee and all patients gave informed consent prior to inclusion in this trial.

Grayscale ultrasonograpgy, power doppler ultrasonography (PDUS), complete examination of thyroid and FNA were performed for each patients. Two radiologists experienced in PDUS examinations were carry out the examinations by using the Sonoline Elegra system (Siemens, Erlangen, Germany) using a 7.5 MHz linear-array transducer. PDUS examinations, including vascular pattern and spectral analysis, were performed by using standard equipment settings for thyroid gland on the Sonoline Elegra system. Nevertheless, in patients with hypovascular thyroid nodules, sensitivity scales were set to their greatest levels (lowest frame rate) to maximize detection of low-velocity flow states. All nodules were examined with the aid of breath and swallow-holding to minimize the motion artifact.

Vascularity was ranked according to PDUS findings graded from 0 to 4, abscent (grade 0), perinodular alone (grade 1), mixed perinodular and intranodular with perinodular prominence (grade 2), mixed perinodular and intranodular with intranodular

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prominence (grade 3) or absolutely intranodular (grade 4), (figure 1 and 2 are example of grade 0 and 1 respectively).

Resistive index (RI) were measured based on the formulas: RI= PSV (peak systolic velocity) - mean diastolic velocity / PSV.[13]

For each nodule the RI value was recorded as the average of the calculations were obtained. Calculations of flow velocities were obtained by angle corrections through the arterial structure as accurately as possible.

After PDUS examination, a sonographically guided FNAB was performed for all nodules by one of two investigators with a 22 G needle. The first pass was obtained without aspiration, and subsequent samples were obtained with aspiration. Cytological material was smeared on slides immediately after aspiration and stained by May-Grunwald-Giemsa stain. All slides were interpreted by an experienced cytopathologist who was blinded to PDUS findings. The final pathological diagnosis for each nodule was made by reports of sonographically guided FNAB or surgical pathological examination, if available, to categorize all nodules as benign or malignant.

Images were electronically stripped of identifying data. Two experienced radiologists without knowledge of clinical outcome independently reviewed each set of images. The findings were then compared with the pathological outcome. The study design was approved by our ethics committee and all patients gave informed consent prior to inclusion in this trial.

Statistical analysis

Statistical analyses were carried out using SPSS (SPSS statistic package, version 21.0.0) statistical software. For statistical analysis, the receiver operating characteristic (ROC) curve analysis was used to evaluate the accuracy of the RI for diagnosing thyroid malignancy. The Pearson Chi square test and the nonparametric Mann-Whitney were used to determine whether there were any significant differences. The estimated sensitivity and the specificity were evaluated for all possible cut-off points, and the optimal cut-off point was assessed for RI. The level of significance was set at $p < 0.05$.

RESULTS

In this study we enrolled 120 thyroid nodules. 28 patients (23.3%) were men and 92 patients (76.7%) were women. The mean age of patients was 44.45±14.3.

In terms of vascularity of nodules, we found that when the vascularity of nodules increased the risk of malignancy of nodules (P-value<0.001) (table 1).

According to presence of peripheral vessels, we found that malignant nodules had more peripheral vessels than benign nodules. The difference were statistically significant (P-value<0.001) (table 2).

Resistive index (RI) was significantly higher among malignant nodules in comparison with benign nodules, 0.73±0.09 and 0.61±0.05, respectively (P-value<0.0001).

Sensitivity and specificity of the RI index for malignancy at the 0.69 cut off point was 71% and 89%, respectively.

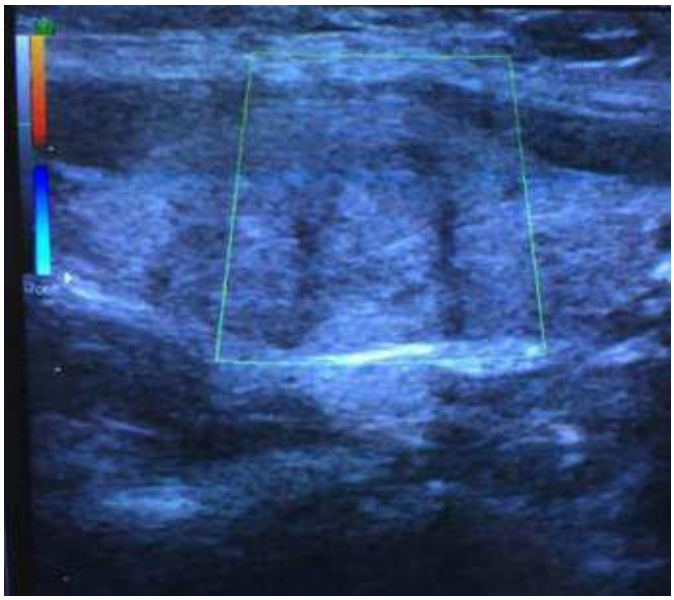

Figure 1. grade 0: absent vascularity

Table 1. Statistical analysis of vascular pattern as determined by power Doppler ultrasound in predicting malignancy in the thyroid nodules

vascularity	Benign N=109	Malignant N=11	Total N=120	P- value
Grade 0	30 (100%)	0 (0%)	30 (25%)	P< 0.001
Grade 1	37 (97.4%)	1 (2.6%)	38 (31.6%)	
Grade 2	22 (95.7%)	1 (4.3%)	23 (19.2%)	
Grade 3	13 (81.3%)	3 (18.7%)	16 (13.4%)	
Grade 4	7 (53.8%)	6 (46.2%)	13 (10.8%)	

Table 2. Statistical analysis of peripheral vessels as determined by power Doppler ultrasound in predicting malignancy in the thyroid nodules

Peripheral vessels	Benign	Malignant	P-value
Yes	2 (1.8%)	6 (54.5%)	<0.001
NO	107 (98.1%)	5 (45.4%)	

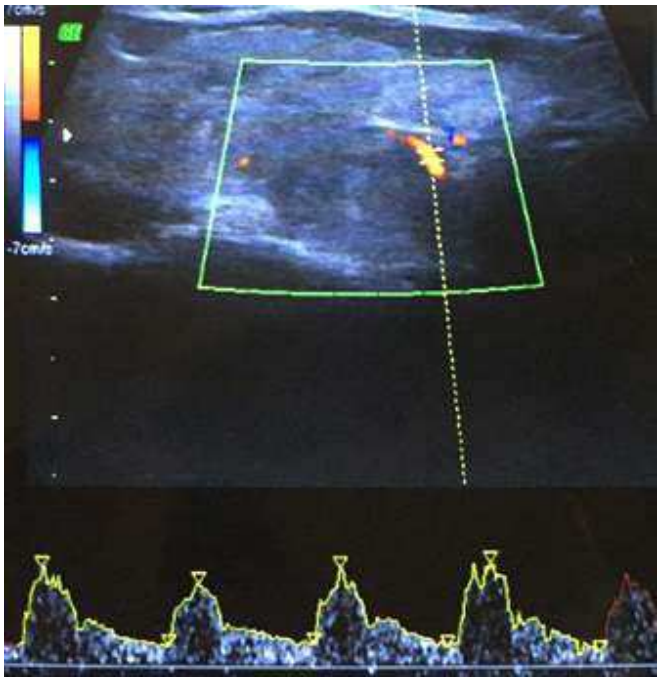

Figure 2. grade 1: exclusively perinodular blood flow, RI=0.79

DISCUSSION

The beneficial role of US has been indicated in the assessment of small thyroid nodules which are impossible to recognize by clinical examination. The most sensitive diagnostic method for intrathyroid nodules is B-mode sonography, but till now there is no specific criteria based on sonographic report to help physicians during the process of evaluation of nodules. vascularization of nodules that is a suggested Criteria to distinguish benign and malignant nodules. Increased vascularization is related to tumor growth. Power Doppler US (PDUS) is now an imaging technique for assessment of vascular patterns inside the thyroid nodules.

In a study performed by Frates et al,[14] some characteristics of thyroid nodules which required undergoing FNAB were mentioned, but the problem is still remain unanswered that whether spectral Doppler US parameters could be used as a diagnostic method to determine which nodules should be studied by FNAB. Recently similar studies focus on the characteristics of PDUS which can help physicians to identifying thyroid nodules with higher probability of malignancy.[11,15-17] In terms of vascularity, previous studies reported different results. Some studies reported that absence of blood flow is only seen in benign nodules.[11,18] But, these reports are not in accordance with studies which evaluated the vascularity in papillary carcinomas an found no blood flow in this carcinoma.[17,19] Clinical experience shows that the absence of vascularity within malignant nodules may be explained by the equipment and methods. Thus, the different report from different studies may occur because of sensitivity level of devices or different methods of radiologists. In this study we found that vascularity of malignant thyroid nodules are mostly intranodular (grade 3 and 4) and less perinodular vascularization, we have no malignant nodule without vascularization. However, in benign nodules lack of vascularization and perinodular vascularization were predominant (grade 0, 1) (table 1). Previous studies reported less vascularity in grade 0 in compare with our study that could be as a result of sensitivity level of devices,[20,21] different methods of radiologists and different protocols. We found, when the vascularity of nodules increased the risk of malignancy of nodules is higher. Also, we showed that malignant nodules had more peripheral vessels than benign nodules (table 2).

Some previous studies have been reported the vascular resistance as a probable predictor to differentiate between malignant and benign nodules.[11,15,16,18,20-22] The Resistive index (RI) is a good spectral Doppler parameter for evaluation of thyroid nodules because it is not dependent on the angle of insonation. According to vascular resistance, Holden et al,[18] reported mean RI values of 0.76 in carcinomas, 0.66 in adenomas and 0.57 in colloid nodules. Also, Cerbone et al,[11] showed that in 18 of 21 carcinomas and in two nodules within 232 benign nodules the RI was greater than 0.75. Recently, many authors reported similar findings in terms of RI values and indicated that this parameter is higher in malignant nodules in comparison with benign nodules.[15,16,21,22] However Tamsel et al.[20] performed a study in 2006 among 169 thyroid nodules and reported that malignant nodules had a mean RI of 0.60 on intranodular arteries and 0.58 on perinodular arteries which showed no significant different in compare with benign nodules. In our study, RI was significantly higher among malignant nodules in comparison with benign nodules, 0.73±0.09 and 0.61±0.05, respectively.

In this study, sensitivity and specificity of the RI index for malignancy at the 0.69 cut off point was 71% and 89%, respectively. Thus, our finding showed that RI index is significant predictor of malignancy and nodules with RI greater than 0.69 have a high risk of malignancy and should be evaluated by FNAB. These finding is in accordance with most of previous studies.[15,16,21,22]

CONCLUSION

We found that Doppler US characteristics (vascular pattern and RI values) were statistically significantly different between benign and malignant nodules. Thus, presence of peripheral vessels pattern and RI assessed by PDUS examination could be used to screening of thyroid nodules.

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REFERENCES

1. Gharib H. Fine-needle aspiration biopsy of thyroid nodules: advantages, limitations, and effect. Mayo Clin Proc. 1994;69(1):44-9.
2. Belfiore A, Giuffrida D, La Rosa GL, Ippolito O, Russo G, Fiumara A, et al. High frequency of cancer in cold thyroid nodules occurring at young age. Acta endocrinologica. 1989;121(2):197-202.
3. Campbell, JP, Pillsbury, HC III. Management of the thyroid nodule. Head Neck. 1989;11:414–425.
4. Kim MJ, Kim E-K, Kwak JY, Park CS, Chung WY, Nam K-H, et al. Differentiation of thyroid nodules with macrocalcifications role of suspicious sonographic findings.

J Ultrasound Med. 2008;27(8):1179-84.

5. Burch HB. Evaluation and management of the solid thyroid nodule. Endocrinol Metab Clin North Am. 1995 Dec;24(4):663-710.
6. Gharib H. Changing concepts in the diagnosis and management of thyroid nodules. Endocrinol Metab Clin North Am. 1997;26(4):777-800.
7. Sangalli G, Serio G, Zampatti C, Bellotti M, Lomuscio G. Fine needle aspiration cytology of the thyroid: a comparison of 5469 cytological and final histological diagnoses. Cytopathology. 2006;17(5):245-50.
8. Elisei R, Ugolini C, Viola D, Lupi C, Biagini A, Giannini R, et al. BRAF (V600E) mutation and outcome of patients with papillary thyroid carcinoma: a 15-year median follow-up study. J Clin Endocrinol Metab 2008;93(10):3943–9.
9. Sharma C, Krishnanand G. Histologic Analysis and Com parison of Techniques in Fine Needle Aspiration–Induced Alterations in Thyroid. Acta Cytologica. 2008;52(1):56-64.
10. Sabel MS, Haque D, Velasco JM, Staren ED. Use of ultrasound-guided fine needle aspiration biopsy in the management of thyroid disease/Discussion. Am Surgeon. 1998;64(8):738.
11. Cerbone G, Spiezia S, Colao A, Di Sarno A, Assanti A, Lucci R, et al. Power Doppler improves the diagnostic accuracy of color Doppler ultrasonography in cold thyroid nodules: follow-up results. Horm Res. 1999;52(1):19-24.
12. Park YJ, Kim J-A, Son EJ, Youk JH, Kim E-K, Kwak JY, et al. Thyroid nodules with macrocalcification: sonographic findings predictive of malignancy. Yonsei med J. 2014;55(2):339-44.
13. Burns PN. Interpreting and analyzing the Doppler examination. Clinical application of Doppler examination 2nd edition New York: Raven Pres. 1995.
14. Frates MC, Benson CB, Charboneau JW, Cibas ES, Clark OH, Coleman BG, et al. Management of Thyroid Nodules Detected at US: Society of Radiologists in Ultrasound Consensus Conference Statement. Radiology. 2005;237(3):794-800.
15. De Nicola H, Szejnfeld J, Logullo ÂF, Wolosker ÂMB, Souza LRMF, Chiferi V. Flow pattern and vascular resistive index as predictors of malignancy risk in thyroid follicular neoplasms. J Ultrasound Med. 2005;24(7):897-904.
16. Chammas MC, Gerhard R, De Oliveira IRS, Widman A, De Barros N, Durazzo M, et al. Thyroid nodules: evaluation with power Doppler and duplex Doppler ultrasound. Otolaryngol Head Neck Surg. 2005 Jun;132(6):874-82.
17. Shimamoto K, Satake H, Sawaki A, Ishigaki T, Funahashi H, Imai T. Preoperative staging of thyroid papillary carcinoma with ultrasonography. Eur J Radiology. 1998;29(1):4-10.
18. Holden A. The role of colour and duplex Doppler ultrasound in the assessment of thyroid nodules. Australasian Radiology. 1995;39(4):343-9.
19. Rago T, Vitti P, Chiovato L, Mazzeo S, De Liperi A, Miccoli P, et al. Role of conventional ultrasonography and color flow-doppler sonography in predicting malignancy in'cold'thyroid nodules. Eur J Endocrinol. 1998;138(1):41-6.
20. Tamsel S, Demirpolat G, Erdogan M, Nart D, Karadeniz M, Uluer H, et al. Power Doppler US patterns of vascularity and spectral Doppler US parameters in predicting malignancy in thyroid nodules. Clinical Radiology. 2007;62(3):245-51.
21. Bakhshaee M, Davoudi Y, Mehrabi M, Layegh P, Mirsadaee S, Rad MP, et al. Vascular pattern and spectral parameters of power Doppler ultrasound as predictors of malignancy risk in thyroid nodules. Laryngoscope. 2008;118(12):2182-6.
22. Bianek-Bodzak A, Zaleski K, Studniarek M, Mechlinska-Baczkowska J. Color Doppler sonography in malignancy of thyroid nodules. J Ultrasound Medicine. 2003;22(7):758.