

Original Research Article

The Use of Power Doppler Ultrasound in the Differentiation Of Benign From Malignant Thyroid Nodules in Duhok – Kurdistan Of Iraq

Maysaloon Shaman Saeed
College of Medicine, University of Duhok, Duhok, IRAQ

E-mail:maysaloonshaman@gmail.com

Accepted 3 July, 2016

Abstract

In the last decade, nodular diseases of the thyroid gland has become an important subject for most of the surgeons and clinicians, trying to reach a proper early detection yielding a preferable outcomes, the study done to evaluate the diagnostic performance of Power Doppler sonography in detecting the nature of thyroid nodules, correlated with fine needle aspiration (FNA) results, helping in the differentiation of their benign from malignant behavior, a total of 200 patients with thyroid nodular disease, age ranging (18 – 69) years, (176 females, 34 males) referred to the radiological department in Azadi teaching hospital, examined by grey scale, color and power Doppler ultrasound; correlation with FNA was done to all nodules, Doppler Ultrasonography is helpful in comparison with FNA results; in the diagnosis of the nature of thyroid nodules, peripheral Doppler vascular arrangements seen more in the benign nodules while central distribution was seen more in the malignant ones.

Key Words: Thyroid, Nodule, Doppler, Power, Vascularity, Ultrasound.

استخدام السونار الملون في التفريق بين عقد الغدة الدرقية الحميدة من الخبيثة

الخلاصة

في الآونة الأخيرة تزايدت امراض الغدة الدرقية و ازدادت معها العقد الدرقية الحميدة منها و الخبيثة و اصبح الوصول الى التشخيص الدقيق لها مهما للعلاج و السيطرة, هدف البحث هو اثبات فاعليه استخدام جهاز السونار الملون في التفريق بين عقد الغدة الدرقية الحميدة من الخبيثة من مجموع 200 مريض, كل منهم لديه عقده في الغدة الدرقية و 176 منهم اناث و 34 منهم رجال تم فحصهم في مستشفى ازادي التعليمي و تم اخذ خزعه لهم بمساعدة السونار و تم اجراء السونار الملون للكشف عن الشكل الذي تترتب به الشرايين و الاورده الدقيقه المزوده للعقد بالدم, كان للسونار الملون دور فعال في التفريق بين العقد الحميدة من الخبيثة حيث تترتب معظم الاوعيه الدمويه المزوده للعقد بالدم بشكل محيطي غالبا في العقد الحميدة و بشكل داخلي اوسط في العقد الخبيثة وان قلة وجود الاوعيه الدمويه في داخل وخارج العقده لا يعني انها ليست خبيثة تماما, من الافضل اجراء السونار الملون لجميع عقد الغدة الدرقية و خاصه للواتي يزيد حجمهم عن الواحد سنتمتر و والتي تكون في الغالب صلبه بطبيعتها.

Introduction

Thyroid nodular disease has relatively high frequency in the general population with prevalence of (4-7%) by palpation alone, and (13-67%) by sonographic evaluation [1,2].

In addition to Conventional Ultrasound , the Power Doppler system is a color mapping technique used to get the strength of the Doppler signal coming from the flow rather than the frequency shift of the signal ,

enables proper estimation of the blood flow based on the number of blood cells regardless of their velocity, so it is considered more sensitive than conventional color Doppler in the imaging of the small

vessels of the tumors [3,4] , the use of conventional and Doppler sonography is more widely applied for the assessment of

suspected malignant lesions (see figure 1) [2-6].

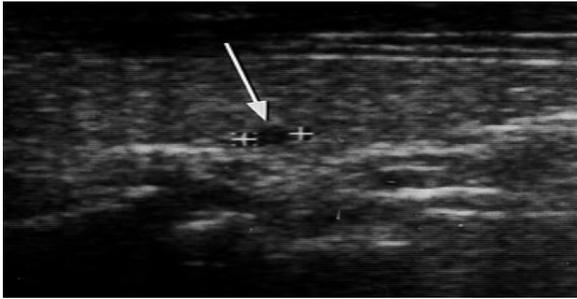


Figure 1 : Sagittal US image shows an anechoic lesion (arrow) 4 mm in diameter in the left lobe posteriorly (between cursors) in a 50 years old man [2].

The exact vascularity of the nodules are well assessed by using Doppler sonography, the pattern of vascularity are classified into Type 0 was defined as no visible flow, Type

1 as predominantly peripheral flow and Type 2 as predominantly central flow, figure 2 [7-10].

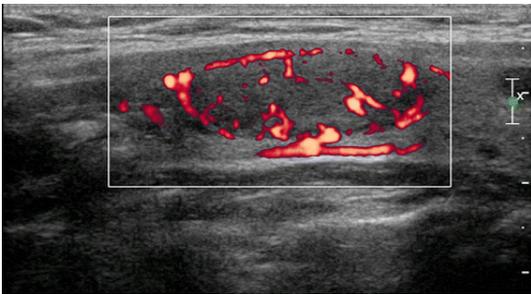


Figure 2 : Power Doppler Ultrasound in 56 years old woman with papillary thyroid carcinoma showing intranodular vascularity [5].

Materials and Methods

A cross-sectional study was performed in which 200 patients were recruited whom referred from physicians and consultants in Azadi Teaching Hospital, diagnosed with different types of thyroid nodular disease. The range of age for the patients was (18 - 69) \pm 7.8 years and their mean was (43.9) \pm 8.9, conducted from June 2014 till October 2015.

All the patients were examined, by two well known specialized radiologists with experience of several years in Doppler and ultrasound examinations using the available Siemens Acuson X300 real time scanner with VF13-5MHz linear array transducer

multidirectional scan; axial, coronal and longitudinal were done for both lobes and isthmus with caudal angulation of the probe in the suprasternal notch to identify any retrosternal extension of the gland. With proper setting of the machine to avoid artifacts and noise, Grey scale, Color Doppler, as well as Power Doppler examination were done, results were all correlated with the results of fine needle aspiration done by two known specialized pathologists. Unfortunately it was not possible to use biopsy as gold standard as many of the patients, preferred to go outside the country and were unavailable to follow up.

Inclusion criteria: nodules more than 1 cm in size .

Exclusion criteria: purely cystic lesions.

The pattern of vascularity arranged relative to each nodule was classified as (Avascular, Predominantly peripheral vascular, Predominantly central vascular) patterns of vascularity [4-10], fine needle aspiration was done for all detected nodules by specialized pathologists, using 10 mm plastic syringes by a specialized histopathologist under ultrasonic guidance, with the use of 22-25 gauge needles, all results were compared with the Power ultrasonic findings.

Data collected using Microsoft Excel 2010 sheet, converted into SPSS version 22

statistical package .Fisher’s exact test was used throughout with a significance level of $P < 0.05$.

Calculations of measures of validity (sensitivity, specificity, predictive values, diagnostic accuracy and likelihood ratios) were done according to Petrie and Sabin [11].

Results

A total number of 200 nodules were examined, 176 of them were in females and 34 in male populations, the age range was between (18 – 69) +_ 7.8, with the mean age of 43.9% +_ 8.9 were seen.

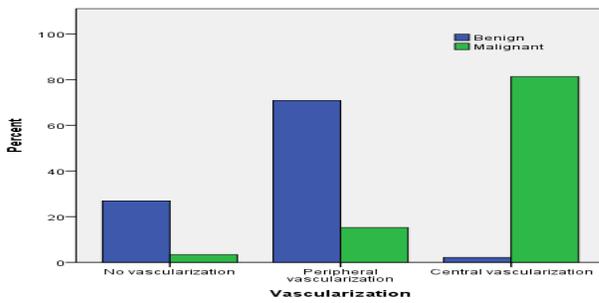


Figure 3: Distribution of different Power Doppler vascular patterns in benign and malignant thyroid nodules diagnosed by Fine Needle Aspiration Biopsy (FNAB)

From the total of the benign nodules, 38 (27 %) were predominantly non vascular, 100 of them (70.9 %) show predominant peripheral vascularity, and 3 (2.1%) show predominantly intranodular central vascularity (figure 3).

From the total of the malignant nodules, 2 (3.4 %) show no vascularity,9 of them (15.3 %) show peripheral vascularity and 48 (81.4 %) of them show central vascularity (figure 4 , table 1) .

Table 1 : Overall distribution of Power Doppler vascular patterns of benign and malignant thyroid nodules (the final diagnosis made by FNAB)

Type of Nodules	No vascularization no. (%)	Peripheral vascularization no. (%)	Central vascularization no. (%)	Total no.
Benign	38 (27.0)	100 (70.9)	3 (2.1)	141
Malignant	2 (3.4)	9 (15.3)	48 (81.4)	59
Total	40 (20.0)	109 (54.5)	51 (25.5)	200

The Avascular pattern of flow was seen in a few cases in the malignant nodules, hence it was included with the peripheral pattern,

both compared statistically with the FNA results.

The sensitivity, specificity, the PPV, and NPV for the non-vascular pattern in detecting the benign nature of the nodules compared with FNA results, were (27%, 97%, 95% and 36% respectively (table 2).

The sensitivity, specificity, PPV and NPV for the peripheral type of vascularity in detecting benign nodular behavior compared with FNA results were 71%, 85%, 92% and 55% respectively (table 2) .

Table 2: Validity of absence of vascularization or peripheral vascularization in the diagnosis of benign nodules, compared with FNA results

	No vascularization	Peripheral vascularization
Sensitivity	0.27	0.71
Specificity	0.97	0.85
Positive predictive value	0.95	0.92
Negative predictive value	0.36	0.55
Diagnostic accuracy	0.48	0.75
LR of a positive test	7.95	4.65
LR of a negative test	0.76	0.34
<i>P</i> -value*	< 0.001	< 0.001

LR: likelihood ratio

* Based on Chi square test.

For the central type of vascularity, the sensitivity, specificity, PPV and NPV in predicting the malignant nature of the

nodules compared with FNA results were 81%, 98 %, 94% and 93 % respectively (table 3) .

Table 3: Validity of central vascularization in the diagnosis of malignant nodules compared with FNA results

	Central vascularization
Sensitivity	0.81
Specificity	0.98
Positive predictive value	0.94
Negative predictive value	0.93
Diagnostic accuracy	0.93
LR of a positive test	38.24
LR of a negative test	0.19
<i>P</i> -value*	< 0.001

LR: likelihood ratio

* Based on Chi square test.

The likelihood ratio (LR) for a positive test result; is the ratio of the chance of a positive result if the patient has the disease to the chance of positive result if he or she does

not have the disease, so the LR for the positive test proved to be valuable in all the three types of vascular patterns seen (table 2, 3).

Discussion

During the past decade the application of Ultrasonography has greatly increased in the differential diagnosis of benign and malignant tumors. Several authors have claimed that Doppler sonography helps considerably [12,13], while others consider this method of limited diagnostic value [14, 15].

In our study females formed the vast majority of the patients examined (four times more than males), and these results were in agreement with [4,15].

In our study, the nodular vascular signals were absent in 27% of benign nodules, these results were comparable with those of [4,5,16,17] and it was absent in 3.4 % of malignant ones which was lesser than those of [4,5], (about 22%) of the total number in both, and this result indicates that absence of vascularity did not exclude malignancy completely, the same that found in [4,5,16,19].

We noticed moderate values of sensitivity and NPV, and hence of the total accuracy of the Avascular pattern in detecting the benign nature of the nodule, this is probably because the term Avascular means deficient vascularity both centrally and peripherally and is more related to the examiner consideration, we hope in the next studies to have a more detailed and exact points to consider the nodule as non vascular with confidence.

Peripheral type of vascularity was more common in benign nodules, in our study, these results were comparable with those found by [4, 5, 15, 16, 17] and showed well sensitivity and specificity values, as well as PPV, the NPV wasn't so high because the nodules size we took were more than 1 cm, while in the study done by [6,9] we noticed more values because the nodules included in their studies were more than 2.5 cm, this reflects that the more the size of the nodule increased, the more properly oriented peripheral distribution of vascularity it has, nearly equal results seen in [5, 14, 15, 19], and slightly lower results seen in [4, 18, 19, 20].

Central type of vascularity was more common in malignant thyroid nodules, also seen in [15, 16, 17, 18, 19, 20] and proved to be highly valuable in predicting malignant thyroid nodules, show in 81% sensitivity, 98% specificity, 94% positive predictive value and 93% negative predictive value, these results were more than those found by [4, 5,15,18, 19, 20] This is probably because in the previous mentioned studies the sample volume was lesser.

The likelihood ratio of a positive test proved to be highly valuable in all the patterns seen, which gives an impression of an accurate, delicate information's, with great power of the ultrasound results in comparing the pretest from post test patients.

Other more detailed studies regarding the malignant nodular behavior and systemic as well lymph node distribution, are hoped in the future.

Conclusion

Power Doppler sonography, although it is less helpful in few non vascular nodules, might contribute in the differential diagnosis of thyroid nodules and helping the physician in reaching exact diagnosis and treatment.

Acknowledgement

Great appreciation to Professor DR. Intisar Salim and DR. Rafil, the two specialized pathologists and Dr. Saleem Khدير, the specialized radiologist, for their kind help and cooperation.

References

- 1-Tan GH, Gharib H. Thyroid incidentomas: management approaches to nonpalpable nodules discovered incidentally on thyroid imaging. *Ann Intern Med.* 1997; 126: 226-31.
- 2-Brander A, Viikinkoski V, Nickles J, Kivisaari L. Importance of thyroid abnormalities detected at US screening. *Radiology.* 2000; 215:801-6.
- 3-Martinoli C, Pretolesi F, Crespi G, Bianchi S, Gandolfo N, Valle M, et al.

Power Doppler sonography: clinical applications. *Eur J Radiol*. 1998; 2:133-140.

4- Emmanuel V, Evaggelos N, Maria T, Emmanuel C. Role of color Doppler ultrasonography in the preoperative management of cold thyroid nodules. *Hormones*. 2007; 6 (1) : 44-51.

5- Hee J, Young J, Min J, Eun J, Eun S, Kyung K. Can Vascularity at Power Doppler US Help Predicting Thyroid Malignancy. *Radiology*. RSNA. 2010; 255 (1) : 260 – 269.

6- Sohn C, Beldemann F, Bastert G. Sonographic blood flow measurements in malignant breast tumors. *Surg Endoscop*. 1997; 11:957-960.

7 - Schick S, Steiner E, Gahleitner A, Bohm P, Helbich T, Mostbeck G, et al. Differentiation of benign and malignant tumors of the parotid gland: value of pulsed Doppler and color Doppler sonography. *Eur Radiol*. 1998; 8: 1462-1467.

8 - Kidron D, Berneim J, Aviram R, Cohen A, Fishman Y, Beyth R. Resistance to blood flow in ovarian tumors: correlation between resistance index and histological pattern of vascularization. *Ultrasound Obstet Gynecol*. 1999; 13: 425-430.

9- Mahira Y, Zeba A. Significance of ultrasound features in predicting malignant solid thyroid nodules. *Journal Of Pakistan Medical Association*. 2015; 13:1-4.

10 - Pedro W, Alexandro L, Michelle A, Maria R. Is Doppler ultrasound of additional value to grey-scale ultrasound in differentiating malignant and benign thyroid nodules. *Arch Endocrinol Metabolism*. 2015; 59:79-83.

11 - Petrie A, Sabin C. Medical statistics at a glance. Third edition. 2009:90-92

12- Holden A. The role of color and duplex Doppler ultrasound in the assessment of thyroid nodules. *Australas Radiol*. 1995; 39: 343 – 349.

13 – Papini E, Guglielmi R, Biancini A, Crescenzi A, Taccogna S, Nardi F, et al

.Risk of malignancy in non palpable thyroid nodules: predictive value of ultrasound and color Doppler features. *J Clin Endocrinol Metabolism*. 2002; 87: 1941 – 1946.

14 – Shiamamoto K, Endo T, Ishigaki T, Sakuma S, Makino N. Thyroid nodules: evaluation with color Doppler ultrasonography. *J Ultrasound Med*. 1993; 12: 673-678.

15- Frates MC, Benson CB, Doubliet PM, Cibas ES, Marqusee E. Can color Doppler sonography aid in the prediction of Malignancy of Thyroid Nodules. *J Ultrasound Med*. 2003 ; 22:127 - 131.

16 – Hamad E, Ibrahim A, Nagla M. Characterization of malignant solid thyroid nodules by Ultrasound and Doppler. *JOSR Journal of Nursing and Health Science*. 2013;4:25-30.

17 – Harley De N, Jacob S, Angela F, Angela M, Luis R, Valcir C. Flow Pattern and Vascular Resistive Index as predictors of Malignancy in Thyroid Follicular Neoplasms. *American Institute of ultrasound in Medicine*. 2005; 24:897-904.

18 – 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. *Clin Radiol*. 2007 ;62 (3) :245 – 251.

19- Yu-rong H, Yu – lian W, Zhi-yan L, Ning – bo W, Xue – ming L. Impact of nodular size on the predictive values of grey scale, color – Doppler ultrasound, and sonoelastography for the assessment of thyroid nodules. *Journal of Zhejiang University*. 2012; 13 (9) : 707-716

20 -Ewelina S, Kosma W, Adam S, Edyta G, Maciej M, Rewaj P, et al. Comparison of Diagnostic Value of Conventional Ultrasonography and Shear Wave Elastography in the prediction of Thyroid Lesions Malignancy. *Public Library of Science PLoS ONE*. 2013; 29 (8):1532-38.