The Egyptian Journal of Radiology and Nuclear Medicine xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

The Egyptian Journal of Radiology and Nuclear Medicine

journal homepage: www.sciencedirect.com/locate/ejrnm

Original Article

Added value of strain elastosonography in prediction of malignancy in solitary thyroid nodule

Mohammed M. Dawoud, Rasha Mahmoud Dawoud *

Radio-diagnosis & Medical Imaging Department, Faculty of Medicine, Tanta University, Egypt

ARTICLE INFO

Article history:
Received 11 April 2017
Accepted 27 June 2017
Available online xxxx

Keywords:
TI-RADS
Strain elastosonography
Solitary thyroid nodule

ABSTRACT

Aim and objectives: To evaluate the diagnostic accuracy of elastosonographyin prediction of malignancy in solitary thyroid nodule.
Methodology: 60 patients (37 females and 23 male) with solitary thyroid nodule were included, their age ranged from 21 to 52 years (mean age 30.6 years), grey scale, color-power Doppler US and elastography were performed for all patient.
Results: Presence of hypoechogenicity, absent halo sign, irregular margins, microcalcifications and predominant intranodular vascularity were the most US patterns predictive of malignancy. Suspicious nodule by elastography (Astria score 3 and 4) were found in 19 nodules (31.7%), 9 of them were benign and 10 of them were malignant with sensitivity 58.82%, specificity 79.07% and accuracy 73.33%, combined suspicious US findings (TIRAD 4&5) and suspicious elastography score (3&4) were most predictive of malignancy which was found in 16 out of 17 nodules with sensitivity 94.12%, specificity 76.74% and accuracy 81.67%.
Conclusion: Combined gray scale, color Doppler US and elastography were more sensitive and accurate than US features alone in prediction of malignancy of solitary thyroid nodules with sensitivity 94.12%, specificity 76.74% and accuracy 81.67%.

1. Introduction

The incidence of thyroid nodules is high even in iodine sufficient countries ranging from 1 to 5% with palpation to 15–68% when assessed by high resolution ultrasound and being more frequent among women and the elderly [1].

Although ultrasonographic (US) examination was considered a method of choice in assessment of thyroid nodules, it had limitation in differentiating benign from malignant thyroid nodules [2].

Some US criteria can target nodules at the highest risk of having thyroid malignancy; these criteria include hypoechogenicity, lack of a complete halo surrounding the nodule, irregular margins, microcalcifications, more tall than wide shape and predominant intranodular vascularity [3,4].

Recently, the Thyroid Imaging Reporting And Data System classification (TI-RADS) enables us to classify nodules according to ultrasound criteria and to determine a risk of malignancy [5].

TIRAD was a classification system has been proposed by Horvath et al. [6], with a modified recommendation from Jin Kwak et al. [7]. Similar to the breast BIRADS category, sonographic TIRADS classification is as follows, TIRADS 1: normal thyroid gland, TIRADS 2: benign lesions, TIRADS 3: probably benign lesions, TIRADS 4: suspicious lesions (subclassified as 4a, 4b, and later 4c [4] with increasing risk of malignancy), TIRADS 5: probably malignant lesions (more than 80% risk of malignancy), TIRADS 6: biopsy proven malignancy.

Elastography is a newly developed technique depending on analyzing the stiffness of a nodule which is related to its composition and cellularity by measuring the amount of distortion that occurs when the nodule is subjected to external pressure, elastography is useful in differentiating malignant from benign thyroid nodules as malignant nodules are harder than the surrounding

Abbreviations: AP/T, anteroposterior\transverse diameter; BI-RADS, breast imaging reporting and data system; FNA, fine needle aspiration; NPV, negative predictive value; PPV, positive predictive value; REC, research ethics committee; TI-RADS, thyroid imaging reporting and data system; US, ultrasonography.

Peer review under responsibility of The Egyptian Society of Radiology and Nuclear Medicine.

* Corresponding author.
E-mail address: roshy_dawoud@yahoo.com (R.M. Dawoud).

https://doi.org/10.1016/j.ejrnm.2017.06.011
0378-603X/

adjacent parenchyma, so elastography increasing the diagnostic accuracy of grey-scale ultrasonography [8,9].

The nodule characteristics (calcifications and cystic components), the experience of the operator and motion artifacts such as carotid artery pulsation are some of the factors the affect the results of elastography [10,11].

In practice, elastography is usually performed as a complementary method for conventional US and not as an isolated test. Many researchers have reported that a combination of conventional US and elastography showed higher sensitivity than conventional US alone. In contrast, the diagnostic accuracy, specificity, and positive predictive value were lower than those of conventional US alone [12].

Other new noninvasive technique to avoid and decrease unnecessary biopsies is diffusion – weighted MR imaging, ADC value is a new promising noninvasive imaging approach that can be used for characterization of solitary thyroid nodules and differentiation between benign and malignant ones. Further studies are needed to determine whether diffusion-weighted MR imaging could be added to the routine imaging technique used for differentiating malignant from benign solitary thyroid nodules [13].

2. Patients and methods

2.1. Patients

Ninety patients presented with thyroid nodules on grey scale US throughout the period from December 2014 to December 2016, 30 patients were excluded from study due to exclusion criteria; cystic nodules (10 patients), nodules with macrocalcification or egg shell calcification (5 patients), multinodular goiter (8 patients), nodule size more than 30 mm (4 patients) or less than 5 mm (3 patients), so the total number of the selected patients were 60 patients (37 females and 23 male). Approval of Research Ethics Committee (REC) and informed written consent were obtained from all participants in the study after full explanation of the benefits and risks of the procedure. Privacy & confidentiality of all patient data were guaranteed. All data provision were monitored and used for scientific purpose only.

Inclusion criteria included patients with solitary solid thyroid nodule, both sexes were included, no age predilection.

2.2. Methods

All patients were subjected to the following:

1. *Full history taking and clinical examination*: personal history, history of present illness, past history with special concern on thyroid disease, general and local examination.
2. *Laboratory investigations included*: thyroid function tests and antithyroid antibody to assure proper thyroid function.
3. *Real time Ultrasound and elastosonography*:
   - Grey scale, color-power Doppler US and elastography were performed using a real time Ultrasound (Toshiba, Apilo 500, TUS-A500), using high frequency probe with frequency of 10 MHz.
   - B mode ultrasound was performed first for all nodules followed by color\power Doppler. Each thyroid nodule evaluated for echogenicity (hypo, iso or hyperechoic), calcification (microcalcification, macrocalcification, egg shell calcification or no calcification), margin (well defined, ill defined), vascularity (peripheral or intranodular) and presence or absent of halo sign.
   - All patients evaluated by stain elastography: the target nodule positioned at center of the a square region of interest box, probe was positioned perpendicular to the skin to avoid carotid pulsations, patient was asked to avoid swallowing during examination, light repetitive compression was applied on the skin above the targeted nodule, the color scale ranged from red, showing areas of greatest strain (ie, softest component), to blue showing no strain (ie, hardest component), evaluation of the nodule elasticity during decompression which is better to reflect the elasticity of tissue.
   - Thyroid nodule elasticity was classified according to Astria classification [14]: a score of 1 denoting elasticity in the whole examined area, a score of 2 denoting heterogeneous elasticity predominantly soft, a score of 3 denoting heterogeneous elasticity predominantly hard, a score of 4 indicated a nodule without elasticity. According to Asteria classification, thyroid nodules with score 3 and 4 were classified as suspicious nodules while thyroid nodules with score 1 and 2 classified as benign nodules.
4. *Histopathological examination*:
   - FNA was performed for all patients under US guidance using a 23-gauge needle attached to a 10 ml syringe.
   - The selected patients underwent surgery for cosmetic reasons due to large nodules or suspicion of malignancy on FNA cytology.
5. *Statistical analysis*:
   - The data were collected, tabulated and statistically analyzed. All statistical analyses were computed with the Statistical Package for the Social Sciences (SPSS) Version 21. Descriptive statistic was performed in a form of number and percentage for qualitative data. Chi-squared test ($\chi 2$) was used to study the significance of association between ealstosonography of thyroid nodule and histopathology. Sensitivity, specificity and diagnostic accuracy were used for grey scale US, color Doppler US, elastography and combined US and elastography diagnostic evaluation. P-value $\leq$.05 was considered significant.

3. Results

The current study included 60 patients with solitary thyroid nodule, 23 (38.3%) of them were male while 37 (61.7%) of them were female, their ages ranged from 21 to 52 years with a mean of 30.6 years. The most affected age group was from 20 to less than 30 years (30 cases) representing 50% of the cases. Demographic characteristics of studied cases are listed in Table 1.

3.1. Pathological diagnosis

Histopathological examination of 60 indeterminate nodules revealed 17 nodules (28.3%) had a pathological diagnosis of malignancy comprised 15 papillary thyroid carcinomas, one medullary carcinoma and one follicular carcinoma. 43 nodules (71.7%) were

Table 1
Demographic characteristics of studied cases.

Characteristics	No. of patients (Total = 60)	(%)
Gender:		
• Male	23	38.3
• Female	37	61.7
Age in years:		
• 20–<30	30	50
• 30–<40	23	38.3
• >40	7	11.7