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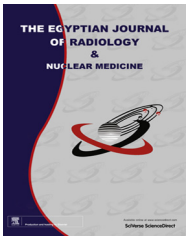

ORIGINAL ARTICLE

Ultrasound elastography in the diagnostic evaluation of indeterminate thyroid nodules

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KEYWORDS

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Thyroid gland;
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Abstract *Objective:* To assess the accuracy of US-elastography in the evaluation of indeterminate thyroid nodules, using the cytological/histopathological analysis as the reference.
Patients and methods: Fifty patients with 73 indeterminate thyroid nodules were enrolled in this prospective study. They were examined using US features and elastography scoring according to Rago criteria; then, fine-needle or postoperative biopsy was taken and diagnosis was made.
Results: Fifty patients with 73 indeterminate thyroid nodules were included, 16 nodules were malignant and 57 were benign. On US elastography, all 57 nodules diagnosed as benign had a score of 1–3, while 15 of 16 (93.75%) diagnosed as carcinoma had a score of 4–5, with 93.3% sensitivity, 100% specificity and 97.8% accuracy. Combined US findings with elastography revealed that hypoechogenicity/score 4–5 was most predictive of malignancy with sensitivity 80%, specificity 100%; and accuracy 93.4%. The strain ratio cutoff value for malignant nodules was determined as 2.3. Five nodules out of sixteen had SR between 2.31 and 4 (sensitivity 96% and specificity 83%).
Conclusion: Thyroid nodules with suspicious US criteria can be evaluated by US elastography that seems to be a useful addition for the assessment of such indeterminate nodules. It may reduce FNAC or select a nodule for aspiration.

1. Introduction

Nodular thyroid disease is a common finding where the majority of thyroid nodules are benign; however, 15–30% of thyroid nodules are classified as indeterminate or suspicious for malignancy (1). The recommended treatment of indeterminate lesions remains the surgical excision of the nodule (2).

Ultrasonographic (US) examination is an accurate method for detecting thyroid nodules, but its use in differentiating between benign and malignant thyroid nodules is relatively low (3). Fine-needle aspiration (FNA), has a high sensitivity and specificity in differentiating malignant from benign thyroid lesions (4). The major limitation of FNA cytology is 10–20% are indeterminate (i.e. unable to discriminate between

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benign follicular adenoma and thyroid carcinoma, either follicular thyroid cancer or the follicular variant of a papillary thyroid carcinoma) (5). Presurgical selection by fine-needle aspiration cytology is limited by the finding of indeterminate diagnosis in approximately 10 to 20% of cases (2). A surgical approach is generally recommended in such nodules even if more than 70% of them are benign at histological examination, so excisional biopsy is the best for differentiation (6).

The newly developed real-time ultrasound elastography (USE) has been previously applied to differentiate malignant from benign lesions and to determine tissue stiffness and strain information noninvasively. The principle of USE is to acquire two ultrasonographic images (before and after tissue compression by the probe), and to track tissue displacement by assessing the propagation of the US beam by a dedicated software. The US elastogram was displayed over the B-mode image in a color scale that ranged from red, for components with greatest elastic strain (i.e. softer components), to blue for those with no strain (i.e. harder components) (7).

2. Patients and methods

2.1. Study patients

The study included 50 consecutive patients with indeterminate thyroid nodules (41 women; median age 46.5 yr; range 19–73 yr/9 men; median age 57.5 yr; range 37–78) seen from May 2012 and August 2013. They were selected according to our inclusion criteria.

Inclusion criteria: Suspicious nodules for malignancy were included in the study with ultrasound criteria of being solid or predominantly solid nodules (cystic portion $\leqslant$ 50%), having hypoechoic pattern, with a predominant vertical development and internal microcalcifications.

Patients with nodules larger than 40 mm, purely cystic without solid components, and shell-calcified nodules that could cause color-coding problems were excluded from the study. Sixteen nodules were malignant and 57 were benign. The final diagnosis was based on the cytology reading in those who did not have surgery and the histopathology reading in those who had surgery.

2.2. Technique of examination

Thyroid US and US elastography were performed using a real-time ultrasound (Toshiba Aplio-XG machine using 10–13-MHz. linear transducer).

The sonographic examinations were performed in three steps. B-mode ultrasound was performed first, then in the second step color Doppler was performed and the third step was real-time sonographic elastography using the same probe during the same examination.

The patient was positioned on his back with the neck is hyper-extended over a pillow and the chin is elevated. The transducer was applied to the neck using adequate amount of gel. Starting the examination with B-mode imaging, during B-mode US, thyroid gland lesions were identified and a region of interest for elastography was identified. A careful evaluation of the following US parameters was performed on all thyroid nodules: echogenicity, presence or absence of the halo sign (a hypoechoic rim surrounding a nodule is comprised of a pseudocapsule that is caused by fibrous connective tissue), spot microcalcifications (presence of hyperechoic spots less than 2 mm, without acoustic shadowing), and color flow Doppler pattern that was defined as (type I) the absence of blood flow, (type II) perinodular and absent or slight intranodular blood flow, and (type III) marked intranodular and absent or slight perinodular blood flow (8).

Shear wave elastography was performed, the probe was placed on the neck with light pressure and a box was highlighted by the operator that included the nodule to be evaluated, and compression was performed repeatedly in a vertical direction with light pressure and was followed by decompression. The pressure must be applied (and released) with a continuous movement exerted at a right angle to the proximal plane of the lesion, and care should be taken to avoid lateral displacement of the probe. A scale is available on the machine to measure whether adequate compression was used (Figs. 1–3).

In the case of multiple nodules, each nodule is evaluated separately and the strain value ratio (strain index) of thyroid nodule to normal thyroid parenchyma or muscle was calculated.

The US elastogram was displayed over the B-mode image in a color scale that ranges from red, for components with greatest elastic strain (i.e. softest components), to blue for those with no strain (i.e. hardest components).

The elastograms thus obtained were classified according to the scores by Rago et al. (9). Elasticity according to Rago et al. (thereafter, Rago criteria) originated from the elastography scale by Ueno et al. (10) and was applied to thyroid nodules and elastography scores were classified on a scale of 1–5. Nodules with Rago scores of 4 and 5 were classified as suspicious for malignancy (Fig. 4).

Thyroid nodule can be evaluated by the following:

2.2.1. Elasticity scores in thyroid nodules

That can be given based on the following criteria (11):

1. Low stiffness over the entire nodule; the entire nodule is evenly shaded green, as is the surrounding thyroid tissue.
2. Low stiffness over most of the nodule; the nodule is almost completely green but with some blue spots.
   - 3a. Low stiffness at the periphery, and high stiffness in the center of the nodule; the central part of the nodule is blue; the peripheral part is green.
   - 3b. High stiffness over most of the nodule; the nodule is almost completely blue but with some green spots.
4. High stiffness over the entire nodule; the entire nodule is evenly shaded blue.
5. High stiffness over the entire nodule and surrounding tissue; both the nodule and surrounding area are blue.

2.2.2. Strain ratio

Strain represents the amount of deformation; thus, stiff tissue shows less strain than softer tissue. A thyroid lesion may have different levels of stiffness within it, depending on the cellularity and the composition of the nodule. Information from these elastograms helps to assess the relative stiffness of the lesion compared with its surrounding tissues and within itself.