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ORIGINAL ARTICLE

Role of ultrasound elastography in assessment of indeterminate thyroid nodules

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KEYWORDS

Ultrasound;
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Abstract *Purpose:* To evaluate the role of ultrasound elastography as an additional technique in differentiating US indeterminate thyroid nodules in order to decrease the number of tissue biopsies.
Methods: We evaluated 30 patients with 36 indeterminate thyroid nodules based on US, criteria, by US elastography, using both the elastography score and strain ratio. Baseband US data were downloaded for off-line analysis. Elastographic maps (color coding) and thyroid stiffness index (strain ratio) were calculated for all nodules, with histopathological results being the standard reference. Receiver operating characteristic (ROC) curve analysis was used to determine the optimal cutoff strain ratio for separating benign and malignant thyroid nodules.
Results: Malignant nodules had a higher degree of color and strain ratio compared to benign nodules, with a statistically significant difference ($p < 0.05$). Nodules with an elastography score of 2 were benign, while those with an elastography score of 4 and 5 were mostly malignant. Malignancy could not be excluded using ultrasound elastography criteria only, in nodules with a score of 3. The sensitivity and specificity of the US-elastography strain color coding for thyroid cancer diagnosis were 91% and 72% respectively. Using ROC analysis, the optimal cutoff strain ratio for separating benign and malignant thyroid nodules was found to be 1.6 with a calculated 89% sensitivity and 70% specificity. The overall accuracy of strain color was slightly better than strain ratio, 91% compared to 86% respectively.
Conclusion: Ultrasound elastography is an easy, non-invasive and rapid technique that can be routinely used in thyroid US scans to select cases for FNAC, and decrease the number of unnecessary biopsies, and consequently decrease the hazards and costs. However, future advances in image acquisition and reconstruction algorithms are required to improve the image quality and clinical usefulness of this technique.
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1. Introduction

Thyroid nodules are very common and may be observed at ultrasonography (US) in 50% of the adult population (1).

Even though most of those nodules are benign, the possibility of cancer must always be considered (2). The imaging

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modality of choice for the investigation of thyroid nodules is high-resolution US, which has markedly improved the detection of thyroid nodules (3). Ultrasound can help in differentiating benign from malignant thyroid nodules. However, individual US features may be of limited value (4). Alternative ultrasound techniques are now being used to improve the diagnostic accuracy of ultrasound, as many suspicious ultrasound features can exist in both benign and malignant nodules (5).

Elastography is a newly developed dynamic technique that uses ultrasound to provide an estimate of tissue stiffness by measuring the degree of distortion under the application of an external force. Like palpation in the assessment of the thyroid during physical examination, elastography uses tissue deformation, or strain, caused by compression and is estimated by precompression and postcompression ultrasonic signals (6).

Using thyroid elastography, significant differences in stiffness between normal thyroid tissue and pathologic thyroid tissue have been found. Although US elastography is not yet used in routine clinical practice, it has been shown to be useful in the differential diagnosis of benign and malignant lesions of the breast (7) and prostate (8).

US elastography is nonstressful for patients, is easy to perform, and requires no more than a few minutes of additional examination time compared with that of conventional US (2). The purpose of our study was to evaluate the role of US elastography as an additional technique in differentiating US indeterminate thyroid nodules in order to decrease the number of tissue biopsies.

2. Patients and methods

2.1. Patients

The study included 30 consecutive patients, including 25 women and 5 men (age range, 23–67 years). They were referred to the Ultrasound Unit at a special radiology center between September 2013 and February 2015. Patients with purely cystic nodules, anechoic nodules without solid components, or with eggshell-calcified nodules were excluded from the study. Each patient signed an informed consent before being enrolled in the study. Most of the patients had multiple thyroid nodules; however, we selected the most indeterminate pattern for the nodule to be enrolled in our study, based on the Revised American Thyroid Association Management Guidelines for Patients with Thyroid Nodules (9), which included the following US features as suspicious or indeterminate: microcalcifications; hypoechogenicity, increased nodular vascularity; infiltrative margins and taller than wide on transverse view (Table 1). The presence of at least one of these indeterminate/suspicious features was sufficient for selection of the nodule in the study. We also included nodules with an absent halo sign, which is considered as an additional, but valuable criterion as well (10). 36 Nodules in these patients were examined by US-elastography. All nodules were subjected to fine-needle aspiration cytology, taken from each nodule separately and patients with a reading of malignant or indeterminate had thyroid surgery.

2.2. Real time ultrasound and US elastography

B-mode ultrasound was performed first for all nodules, followed by color-power Doppler. The following US parameters were evaluated in all thyroid nodules: presence or absence of the halo sign, the margins (regular or irregular), the relation between the height and width of the nodule and the presence or absence of microcalcifications. Micropure imaging was applied to help detect microcalcifications. Micropure imaging algorithm (Toshiba) (11) is an adapted filter that is used to enhance bright echoes to visualize and show calcifications, particularly microcalcifications. Positive blood flow, whether perinodular or intranodular, on color Doppler was also documented. Only nodules with an indeterminate or suspicious feature were further evaluated by ultrasound elastography, and an elasticity score and strain ratio index were determined for each nodule. All patients were examined with a 10–13-MHz. linear transducer (Hitachi medical system EUB 7000/Toshiba Aplioi XG machine). The transducer was applied to the neck using adequate amount of gel, the neck was hyper-extended and the chin was elevated. The grayscale sonography and elastography were performed by the same radiologist in all patients, to prevent differences among operators and to standardize the degree of manual pressure. The pressure, which was able to sustain the scale number between 2 and 4, for a minimum of 3 s, was set as the optimal pressure. The region of interest (ROI) was centered on the lesion, including sufficient surrounding thyroid tissue. Patients were asked to try to avoid swallowing during the examination to minimize movement of the thyroid gland.

Table 1 The Correlation between Conventional ultrasound and Doppler findings of thyroid nodules, with the pathological diagnosis.

Features *n*(%)	Cytology		
	Benign	Malignant	
Halo sign			
Absent	3(13%)	12(92%)	0.000 (HS)[a]
Present	20(86.9%)	1(8%)	
Margin			
Irregular	19(82.6%)	9(69.3%)	0.39 (NS)[a]
Regular	4(17.4%)	4(30.7%)	
Height and width			
Wider than tall	21(91.3%)	7(53.8%)	0.44 (NS)
Tall than wide	2(8.7%)	6(46.2%)	
Calcification			
Absent	18(78.2%)	7(53.8%)	0.11 (NS)
Present	5(21.7%)	6(46.2%)	
Doppler			
No flow	4(17.5%)	0	0.22 (NS)
Perinodular	11(47.8%)	5(38.4%)	
Intranodular	8(34.7%)	8(61.5%)	

[a] HS = highly significant value, NS = non-significant value.

2.3. Elasticity scores in thyroid nodules

Ultrasound elastography was color coded between red (softest component) and blue (hardest component) based on five point scale according to the classification proposed by Yerli et al. (12):

Score 1: Diffuse elastic pattern (homogeneously diffuse green).

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