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Original Article

Additional value of qualitative strain ultrasound elastography and strain ratio in predicting thyroid malignancy

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A B S T R A C T

Objective: To detect if strain ultrasound elastography and strain ratio have additional value to the conventional grey scale ultrasound in predicting thyroid malignancy.

Patients and methods: This study included 92 thyroid nodules from 62 patients (the mean age was 40.64 ± 13.93). Morphologic aspects of the thyroid nodule in conventional grey scale ultrasonography and elastographic examinations with elastography score and strain ratio (SR) were performed for all nodules. The final diagnosis was confirmed by fine needle aspiration biopsies in 72 nodules and by excisional biopsies in 20 nodules.

Results: We found that combination of both conventional ultrasound and strain elastography score have the best diagnostic performance with sensitivity, specificity, PPV, NPV and accuracy accounting for 80%, 97%, 57%, 99% and 96% respectively. The means SR for benign nodules (1.37 ± 0.56) was significantly lower than that for malignant nodules (3.0 ± 0.71) [p-value .003].The optimal SR cutoff is 2.5 with estimated 80% sensitivity, 98% specificity, PPV 67%, NPV 99% and accuracy 97%.

Conclusion: The clinical application of elastography score and SR should be carried out hand in hand with conventional sonographic assessment of thyroid nodules to achieve the best diagnostic performance.

1. Introduction

Thyroid gland nodules are common and palpable nodules are found in 4% to 7% of the adult population [1,2]. Widespread use of ultrasound (US) imaging and development of high-resolution scanners have significantly improved the detection of thyroid nodules [2]. According to US imaging and autopsy results, the incidence of thyroid nodules may increase up to 50% of population [3–5]. The rate of malignancy among thyroid nodules ranges between 5% and 15% [6,7].

US imaging is a definitive method for detection of thyroid nodules; however, the predictive value of US in differentiation of malignant nodules is limited [8,9]. Currently, the best available method for discrimination of malignant from benign thyroid nodules is fine needle aspiration biopsy (FNAB) [10–12]. Despite its high sensitivity and specificity, FNAB is an invasive procedure and may give non diagnostic results in 10% to 20% of biopsies [6].

Elastography is a recently introduced noninvasive technique which use ultrasound to estimates the stiffness of tissues by assessing distortion under compression [13,14]. US elastography has been successfully applied in the breast and more recently in the prostate gland and lymph nodes [15,16].

By another means, elastography being a stiffness imaging modality which acquires information on the movement of tissue in response to a small applied pressure. In softer tissues, applied pressure causes the tissue to compress more whereas hard tissues compress less. This compressibility property is known as strain and it is displayed as an image (elastogram) or measured, using dedicated software [17].

Recent researches have assessed the role of ultrasound elastography in differentiating malignant from benign thyroid nodules and they suggest that elastography can increase the ability of ultrasound in predicting thyroid malignancy [17,18].

There are two accessible types of US elastography applied to thyroid gland, strain elastography (SE), with its qualitative and semi-quantitative variants (strain ratio) and shear wave elastography (SWE) [17,18]. SE is the most widely available method in

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commercial units. With the compression of the probe, it measures the shape-deformation, providing a value of lesion stiffness compared to that of surrounding tissue. The induced displacements are estimated by tracking the echo delays acquired before and after the compression and assessed by a dedicated software [19,20].

This study aims to detect the value of elastography score and strain ratio as an effective non-invasive adjuvant to grey scale ultrasound in differentiating malignant from benign thyroid nodules.

2. Patients and methods

A total number of 62 patients with thyroid nodules (51 females and 11 males, the mean age was 40.64 ± 13.93) were involved in this study in the time from March 2016 to February 2017. The institutional review board of our hospital approved this study and informed consent was obtained from all patients.

Fifty patients were presented with palpable thyroid masses while in 12 patients the thyroid nodules were found incidentally during neck ultrasound examination. Selection of the nodule was according to our inclusion criteria.

2.1. The inclusion criteria

Thyroid nodule suspicious for malignancy with one or more of the following ultrasound criteria:

I. Completely solid or predominantly solid nodule (cystic component ≤15%).
II. Nodule with hypoechoic pattern.
III. Nodule with internal calcifications (micro calcifications or coarse calcifications).

2.2. The exclusion criteria

I. The presence of cystic component >15% of the nodule volume.
II. Purely cystic nodule.
III. Large nodule (>85% of thyroid lobe volume or >5 cm) in order to have sufficient reference normal tissue.
IV. Nodule with shell calcification.

Imaging was performed using ultrasonographic machine (Samsung Medison's Technology: RS80A with Prestige) with a 12.3-MHz linear array probe.

Conventional B-mode US image was obtained first to assess the morphologic appearance of the thyroid nodule including:

I. Nodule size [<1 cm, 1–2 cm and >2 cm].
II. Nodule margins [irregular or regular].
III. Nodule echogenicity [hypoechoic, hyperechoic or isoechoic].
IV. The presence or absence of calcifications [either micro calcification or coarse calcification].

After Conventional B-mode US image acquisition, elastography was obtained using the built-in elasto software.

While the patient lying supine US probe placed on the neck and the operator defined a box, which incorporate the nodule with or without adequate surrounding normal thyroid tissue.

Gentle sustained freehand manual compression was applied on the neck. The stiffest structures (with lowest elastic strain or no strain) are displayed in blue or red according to the machine software (on our machine, was displayed in red color), while the soft, most deformed tissues (with greatest elastic strain) are displayed in red or green or blue according to the manufacturer (on our machine, was displayed in blue color).

Each thyroid nodule was given an elasticity score according to the 4 scales scoring system of Asteria et al. [21], based on the predominant color pattern of the nodule.

Score (1): elasticity is present in the whole examined area.
Score (2): elasticity present in a large area of the examined nodule.
Score (3): stiffness seen in a large part of the examined nodule.
Score (4): represent a nodule without elasticity.

One ROI was drawn over the nodule and the reference normal thyroid tissue, and a strain ratio was generated in the device. A semi-quantitative evaluation of strain ratio: the strain near carotid artery (high strain area) divided by the thyroid nodule strain, is termed elasticity contrast index (ECI) in our equipment. It was calculated automatically by the machine software.

3. Results

This study included 62 patients with 92 thyroid nodules. The final diagnosis was obtained by ultrasound guided fine needle aspiration biopsies in 72 nodules or by excisional biopsies in the other 20 nodules and revealed benign outcome in 87 nodules (94.57%) and malignant outcome in 5 nodules (5.43%) [Table 1].

Table 2 shows the different sonographic findings detected by grey scale ultrasound (number of nodules, nodular margins, nodule hypoechogenicity and calcifications) and their correlation with the results of the pathology.

Multiplicity of nodules favors benignity while the less the number of nodules, the more we can suspect malignancy. This was a statistically significant finding (P-value = .02) with sensitivity and specificity 100% and 56% respectively.

The margin irregularity was not statistically significant (P-value = .1), it was found in 3 malignant nodules (60%) and in 17 benign nodules (19.5%). The sensitivity was 60% and specificity was 80%.

Nodule hypoechogenicity was observed in 4 (80%) malignant nodules and in only 7 (8.05%) benign nodules with a statistically significant difference (P-value = .004). It is a finding of high sensitivity and specificity (80% and 92% respectively).

Calcifications exist in 4 malignant nodules (80%), micro calcifications in 3 nodules and coarse calcification in 1 nodule. Four benign nodules (4.6%) showed coarse calcification. P value was significant (.001). It has a high sensitivity and specificity as well (80% and 95% respectively).

The correlation of 4-scale elastography scoring system with the histopathological results was statistically significant. The first two scores (1 and 2) were considered in favor of benignity and scores 3 and 4 in favor of malignancy. Hence, we gathered the first two scores (1 and 2) and the other two scores (3 and 4) in two categories for better and easier clinical application and results interpretation.

Eighty-six nodules (93.48%) got score 1 or 2 (59 with score 1 and 27 with score 2), eighty-four (97.67%) out of these 86 nodules were benign and 2 (2.33%) were malignant by histopathological assessment. Six nodules (6.52%) got score 3, three (50%) out of

Table 1
Final diagnosis according to pathology.

Pathology	Number	Percentage
Benign	87	94.57%
Malignant	5	5.43%