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Quantitative Elastography – A useful ultrasound tool for differentiating thyroid lesions?

Vito Cantisani, Olena Medvedyeva, Matteo Olive, Paolo Ricci

UOS di Ecografia ed Eco-color-Doppler, Dipartimento di Scienze Radiologiche
Azienda Policlinico Umberto I, Sapienza Università di Roma, Roma

Introduction

Thyroid nodules are very common. While ultrasound has a high sensitivity for the detection of thyroid lesions, its specificity – the ability to differentiate between benign and malignant nodules – is limited. Color Doppler can provide information on hypervascularity, one of the most prominent features of malignancy, albeit not reliably. That means, neither general ultrasound nor color Doppler offers high sensitivity and specificity.

Palpation is a conventional method to assess thyroid nodules since malignant tissue tends to be harder than benign tissue. Based on this principle, elastography was developed as a non-invasive ultrasound procedure to gather information on tissue stiffness. In order to be palpable, the object must be harder than the surrounding tissue. To date, however, only morphologic (i.e. qualitative) findings have been proposed.

Quantitative elastography is a more sophisticated method to assess tissue hardness. It investigates the mechanical and elastic properties of the soft tissues which rely on the composition and structural organization of macromolecules. Strain values of nodules and normal thyroid parenchyma can be obtained by exerting pressure on the thyroid tissues with the ultrasound probe. Quantitative elastography provides time elasticity graphs to be plotted over a region of interest in the compression or relaxation cycles. This allows the quantitative evaluation of tissue stiffness. In quantitative elastography two images (before and after tissue compression by the probe) are acquired and tissue displacement is tracked by analyzing the propagation of the imaging beam. The dedicated software is able to provide an accurate measurement of tissue displacement and stiffness.

The purpose of the present case study is to show the clinical value of quantitative elastography in differentiating histologically proven benign and malignant thyroid nodules in comparison with color Doppler ultrasound.

Case report

This case report includes two patients admitted to our hospital for thyroidectomy. The first patient was a 22-year-old woman who presented with a thyroid nodule that had recently been increasing in size. The patient underwent fine needle aspiration biopsy (FNAB) and eventually thyroidectomy.

On palpation the nodule appeared firm and inelastic. At color Doppler ultrasound the lesion was hypoechoic with irregular margins and peripheral vascularization (pattern II). In selective high-resolution elastography the polychromatic map that was obtained showed a homogeneous blue nodule which indicates a score of 4. Additional strain imaging allowed the analysis of the strain ratio and yielded a value of 5.5. These results indicated the malignant nature of the nodule which was confirmed at histology.

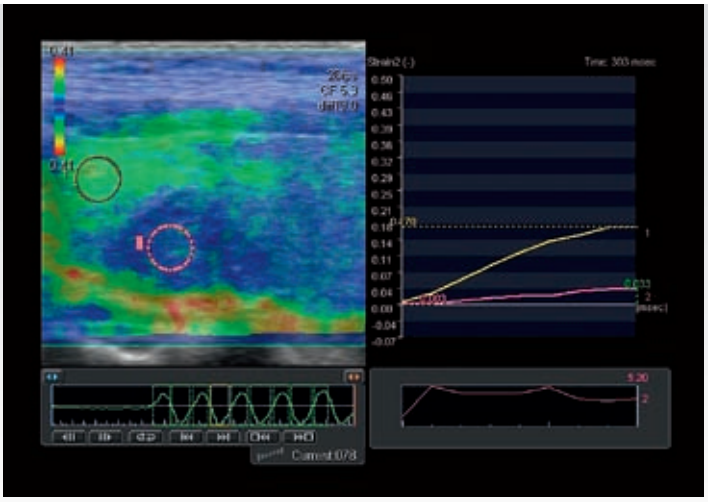

Fig. 1: At high-resolution elastography (left – polychrome map) the thyroid nodule was completely blue, thus corresponding to score 4 of the Ueno Classification. The strain ratio (right) was 5.5, indicating malignancy of the nodule which was confirmed at histology.

The second patient was a 58-year-old man with thyroid multinodular goiter. He underwent thyroidectomy due to compression symptoms. Only one of the thyroid nodules, which had sharp margins, was analyzed. It showed slight hyperechogenicity with some cystic changes and peripheral and intranodular vessels (pattern III) but low RI (0.65) at color Doppler ultrasound. The post-compression map was predominantly green with some blue areas which corresponds to pattern II of the Ueno classification. In addition, strain imaging allowed analysis of the strain ratio which yielded a value of 0.75. Histology confirmed that the nodule was an adenoma.

Discussion

To date, FNAB is still considered the gold standard for optimal characterization of thyroid lesions. However, palpation is an important part of the diagnostic work-up since usually firm and inelastic lesions are considered suspicious to be malignant. The determination of elasticity allows accurate differentiation between benign and malignant thyroid nodules. The ability to demonstrate tissue elasticity by real-time ultrasound using the polychromatic elastographic map and offline quantitative analysis of the strain field, as shown in the present case report, resulted in a more accurate characterization. Two different methods of thyroid strain imaging were used in the present study: real-time elastography implemented on an ultrasound scanner which provides a polychromatic elasticity map and off-line processing strain images reconstructed from RF data stored during the ultrasound examination (quantitative elastography). After compression of the lesion, the part of the compressible cycle which was more symmetric, thus corresponding to the optimal compression, was used for quantitative evaluation. Therefore we evaluated the strain ratio and the strain velocity corresponding to the higher acceleration value. The preliminary results of our pioneer study indicate that quantitative elastography is a useful tool to characterize thyroid nodules since it is more accurate than color Doppler ultrasound. Further studies are required.

Practical conclusion

Elastography enables differentiation of thyroid lesions. Preliminary results of our experience showed improved sensitivity and specificity over color Doppler ultrasound. The possibility to obtain quantitative data such as strain ratio and velocity ratio may help to achieve objective results.

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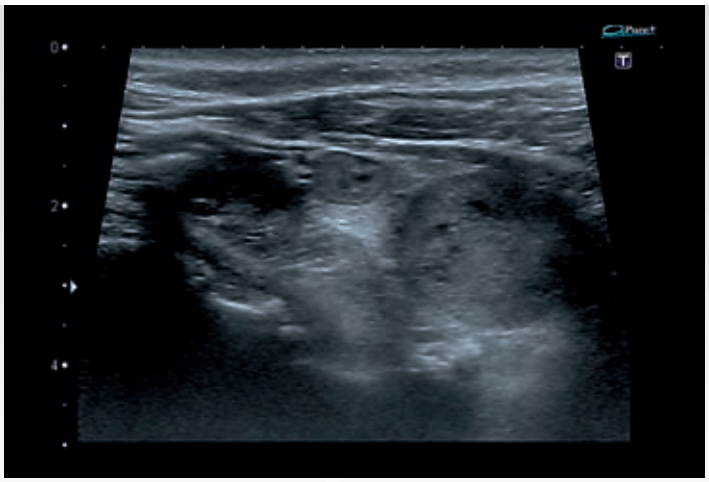

Fig. 2a: At baseline sonography, the lesion appeared well delineated, slightly hyperechoic and with some cystic changes.

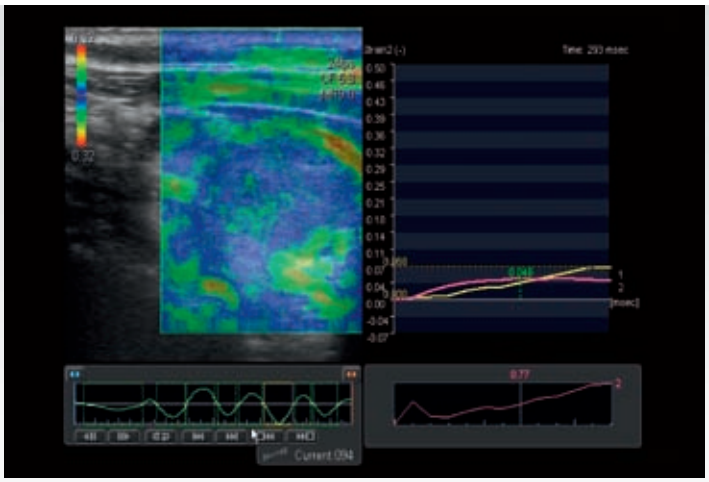

Fig. 2b: The polychrome map showed a lesion with score 2 and a strain ratio of 0.75. Histology confirmed the benign nature of the nodule.

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