

Precision Medicine with 3D Ultrasound

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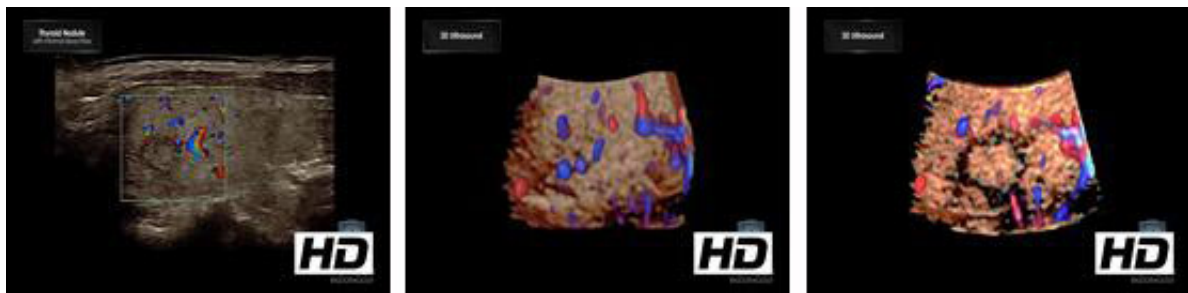
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Abstract

Introduction: Currently, B-mode ultrasound (US) is the primary imaging modality in diagnosing thyroid nodules (TNs). B-mode is a two-dimensional US (2D US) imaging display. Recent studies suggest a role for strain and shear wave elastography for evaluating TN as well. Three-dimensional US (3D-US) has the potential to enhance the diagnostic accuracy and precision for thyroid cancer (TC) detection.

Materials and Methods: An experienced ultrasonographer (G.A.) evaluated the patient using the following techniques: B-mode, strain and shear wave elastography, and 3D-US followed by fine needle aspiration biopsy (FNAB). Laboratory measurements were performed at LabCorp. Informed consent was obtained.

Case: A 28-year-old woman referred for hypothyroidism. Her primary doctor initiated levothyroxine 50 mcg daily 6 months prior. At the time of her visit, her thyroid stimulating hormone (TSH) was 2.8 (0.45–4.5 uIU/mL) and both thyroid peroxidase and thyroglobulin antibodies were elevated, suggestive of Hashimoto's thyroiditis. Her thyroid US showed a heterogeneous gland with an isoechoic TN in the right lobe measuring $7.7 \times 6.3 \times 7$ mm. Strain elastography showed diffuse and patchy tissue stiffness throughout the gland, suggestive of tissue fibrosis caused by Hashimoto's thyroiditis. This study did

not distinguish target TN from the surrounding tissue. Shear wave elastography of the TN revealed moderately increased stiffness compared with surrounding tissue. The shear wave velocity (SWV) measurement for the TN was 3.1 m/s. 3D-US examination demonstrated an isoechoic TN with irregular margins, and the volume was 0.119 cm³. FNAB of the TN was performed. Cytopathology was diagnostic for papillary thyroid cancer (PTC), Bethesda Category VI. Subsequent total thyroidectomy confirmed a 7 mm PTC with positive surgical margins caused by thyroid capsule invasion and no clear-cut evidence of extra-thyroid extension.

Discussion: This case showcases the recent technological advances in TN imaging. Our objective is to provide an improved approach to TN management. The American College of Radiology Thyroid Imaging Reporting and Data System stratifies the malignancy risk of TN primarily based on the size and B-mode US features. This model does not recommend FNAB for any TN <10 mm regardless of malignancy risk.¹ This is our observation that with 3D-US the size cutoff of TN might not be an issue as with B-mode or elastography. Irregularities of the TN can be seen with 3D-US with small and large nodules equally. The finding of irregular margins on 3D-US and consulting with the patient lead us to perform FNAB. Recent publications in the journal of VideoEndocrinology showed utilizations of 3D-US in diagnosing parathyroid adenomas and TNs.

3D-US technology improves view of the target lesion by adding a third dimension, coronal view, to the transverse and longitudinal views of B-mode US.^{2,3} B-mode imaging provides excellent view of TNs. However, it has a low sensitivity for predicting TC.⁴ Prospective TN studies have demonstrated that adding elastography to B-mode imaging improves sensitivity of US technology for detecting TC.⁵⁻¹⁰ In a prospective study with 707 TN, we showed that a single cutoff analysis for predicting malignancy in TNs, a maximum SWV of 3.54 m/s had the best sensitivity. The mean SWV for benign nodules was 2.71 m/s. The mean SWV for malignant nodules was 3.96 m/s.⁶ In this particular case strain and shear wave were not as helpful. The discrepancy between the two systems has been described in cases with severe Hashimoto's thyroiditis associated with tissue fibrosis.⁶ In our experience, the presence of autoimmune thyroid disease increases the risk for malignancy. Recent publications reported an association between differentiated TC and autoimmune thyroid disease and/or TSH when all Bethesda classifications were included.¹¹⁻¹³

Conclusion: 3D-US technology in conjunction with B-mode may improve diagnostic accuracy in detecting TC.

No competing financial interests exist.

Runtime of video: 2 mins 30 secs

Keywords: 3D ultrasound, thyroid nodule, thyroid cancer

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