

Assessment of Low-Flow Fetal Pathology using SMI

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Introduction

In the following case study, a novel Doppler ultrasound technology, Superb Micro-vascular Imaging (SMI) from Canon Medical Systems, was utilized to better visualize small vessels within a fetal goiter. SMI uses a clutter suppression algorithm to extract low velocity flow at high frame rates to provide high resolution vessel branching details when compared to conventional Doppler techniques. The enhanced Doppler sensitivity enabled by SMI provides novel opportunities for prenatal characterization of vascular patterns.

History

A 28-year-old pregnant woman presented to our ultrasound unit with a history of Grave's disease and thyroidectomy. She had been followed with serial ultrasound scans for mild fetal tachycardia and small fetal goiter beginning at 19.4 weeks of pregnancy. She was treated with methimazole for hyperthyroidism. Increased amniotic fluid volume developed by 35.2 weeks gestation. At that time, she was scanned to examine the fetal goiter in more detail.

Technology

The patient was imaged using an Aplio i800 ultrasound system (Canon Medical Systems USA, Tustin, CA) using a i8CX1 transducer. Ultrasound settings, including velocity scale and gain, were optimized for flow conditions. Color Doppler velocity scale was typically set to 20.9 cm/s, color frequency 3.5 MHz with a color filter setting of three. The SMI scale was standardized to approximately 1.7 cm/sec, frequency of 3.5 MHz, and color filter of four. Region of interest box size was not changed when comparing color and power Doppler images as well as between both SMI modes. SMI yielded about 50 frames per second and color Doppler about 10 frames per second in most cases.

Findings

A small fetal goiter was present without evidence for hydrops. Amniotic fluid was moderately increased (AFI = 25.4 cm). The estimated fetal weight was 2,934 g (72nd percentile).

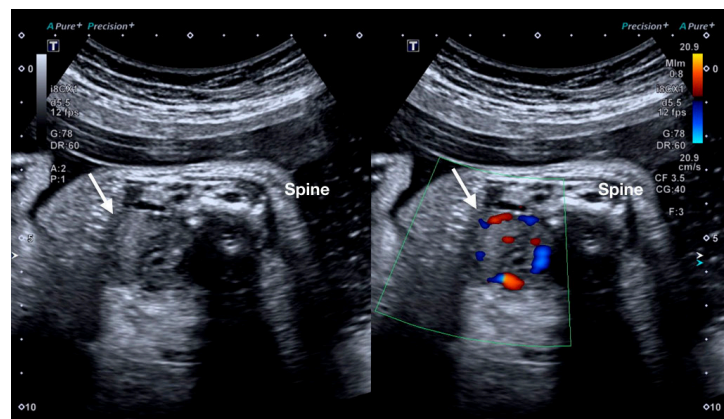


Figure 1. Gray scale ultrasound of fetal neck (left panel) with conventional color Doppler ultrasonography used to examine vascularity of an anterior goiter (white arrows).

She delivered a term 3,135 gram female infant with low TSH, low normal T4, and low free T4 levels. The infant demonstrated evidence of central hypothyroidism by seven months of age.

Discussion

Fetal goiter can occur with maternal thyroid levels that are low, normal, or high. In this case, Doppler imaging of the thyroid microvasculature did not contribute to a change in pregnancy management although it did provide an opportunity to document visual differences in the degree of tissue vascularization depending on the Doppler technology being used. Conventional Doppler imaging techniques, such as color and power Doppler ultrasonography, were unable to display small vessels with low flow rates in this particular case. A recent article described the evaluation of fetal thyroid function using 3D gradient echo T1-weighted MR imaging. By analogy, a robust assessment of organ microvasculature, using more sensitive Doppler imaging technologies such as SMI, could provide novel opportunities for monitoring pathological low-flow microvascular conditions in fetal or placental tissues. Future directions could further classify microvascular tissue characteristics during pregnancy, particularly if new software tools were developed to quantify these changes.

References

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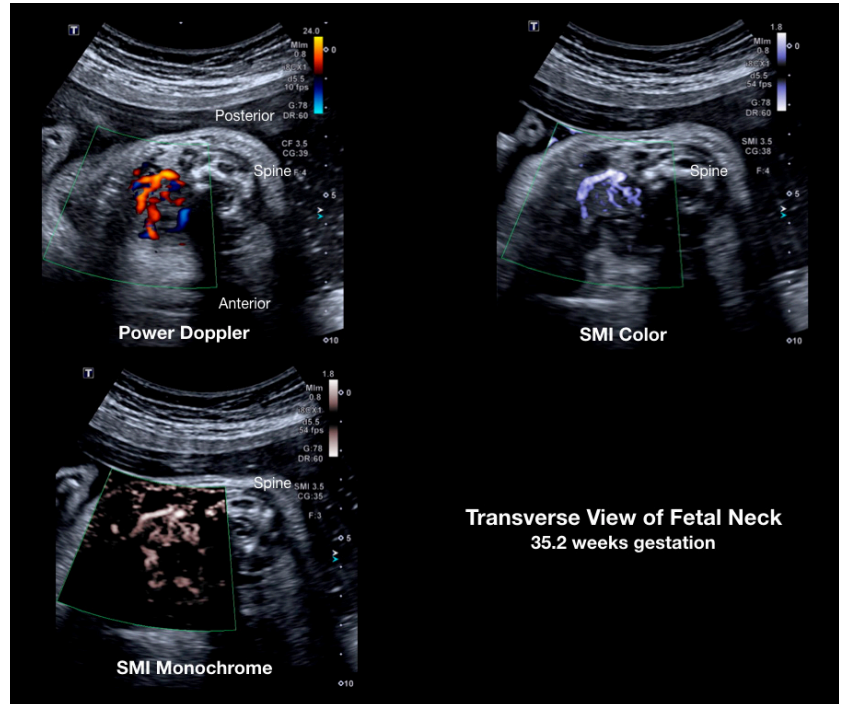


Figure 2. Power Doppler, SMI color Doppler, and SMI monochrome Doppler ultrasonography are used to examine vascularity of fetal goiter. The SMI monochrome technology demonstrated the highest degree of resolution for details of the microvasculature (bottom left image).

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