

Progress in the Ultrasonographic Microvascular Imaging

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Color Doppler flow imaging (CDFI) is the most common ultrasound blood flow imaging tool and can be used to determine the characteristics of blood flow in various organs, tissues, and lesions. However, CDFI is relatively insensitive and highly subject to interference during imaging of capillaries with low-velocity blood flow.

The use of contrast-enhanced ultrasound (CEUS) can ensure that the vascular signals received from lesions under evaluation are enhanced (due to the enhanced reflections from the contrast agent). Therefore, CEUS can give ultrasound examiners greater diagnostic confidence in determining the morphology of microvascular perfusion in local lesions. Benign or malignant liver tumors (such as primary liver cancer, metastatic liver cancer, focal nodular hyperplasia, and hemangioma) have a different vascular framework. CEUS is able to observe the blood vessel number, morphology, and routing distribution and thereby are useful differential diagnosis of tumor nature.

Although it is currently one of the most sensitive and objective methods to observe capillary perfusion, CEUS it is not yet widely adopted in Taiwan as it requires the use of expensive special contrast agents, ultrasound imaging software, and equipment.

Toshiba medical has recently developed a new Doppler microvascular imaging technique known as superb microvascular imaging (SMI),^[1] that can separate Doppler signals generated by low-velocity blood flow from Doppler signals generated by tissue movement. This technique can reduce motion artifacts, and can simultaneously provide a high level of sensitivity and imaging resolution. As a result, ultrasound examiners using this technique can clearly observe low-velocity capillary blood flow without the need for a contrast agent, which can increase confidence in the assessment of the nature of tumors.

Using this technology, we performed routine ultrasound follow-up on a 40-year-old female patient diagnosed by CT scan with focal nodular hyperplasia [Figure 1].^[2] While a

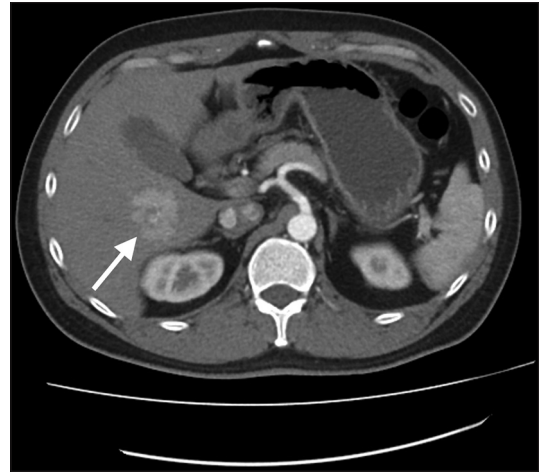


Figure 1: Abdominal computed tomography revealed a hypervascular lesion over right lobe of liver (arrow)

central scar could be seen in the patient's tumor [Figure 2, left] using an ordinary ultrasound system (Toshiba Aplio 500), SMI allowed us to clearly see the spoke-wheel sign of capillaries within the tumor [Figure 2, right], enabling a more confident diagnosis of focal nodular hyperplasia.

The SMI technique has other uses apart from the diagnosis of liver tumors. We have also used the SMI technique to aid in the diagnosis of intramural hematoma after an abdominal CT scan revealed intestinal wall thickening [Figure 3] over a long section of the small intestine in a 77-year-old patient who had sought medical attention for acute abdominal pain.^[3] In this case, SMI revealed that the thickened intestinal wall still had capillary blood flow [Figure 4], allowing her physician to eliminate bowel ischemia as the etiology of her pain (Figures 1-4 have been partially picked from the previous publication as noted in Reference 2 and 3). Since

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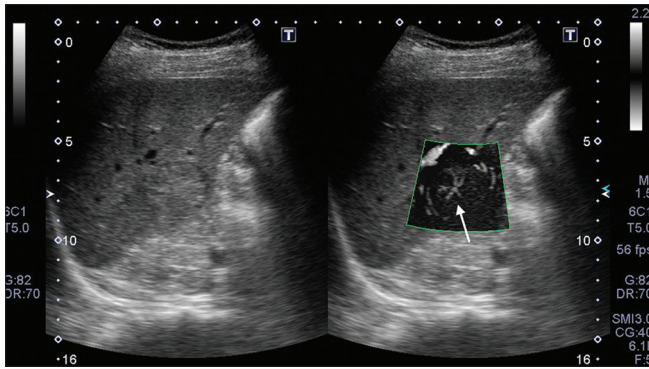


Figure 2: Abdominal ultrasound of the liver tumor (left) and spoke-wheel sign can be revealed by superb microvascular imaging (right, arrow)



Figure 3: Abdominal computed tomography revealed a segmental small bowel wall thickening (arrow)

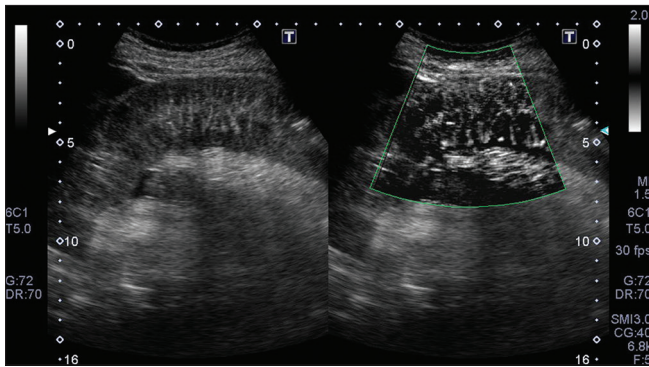


Figure 4: Abdominal ultrasound revealed bowel wall thickening (left) with presence of capillary blood flow (right)

the patient had a history of anticoagulant use, the diagnosis of intramural hematoma of the intestine was confirmed by endoscopy [Figure 5], and her symptoms improved after the patient stopped the use of anticoagulants.

CONCLUSIONS

Ultrasound capillary imaging methods such as SMI offers a fast, economical method for examiners to obtain clear images of tissue capillary morphology and distribution which can increase diagnostic confidence when using ultrasound.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

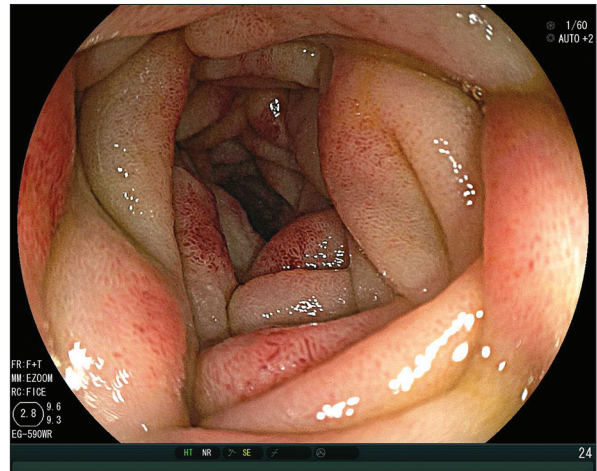


Figure 5: Enteroscopy revealed patchy ecchymosis of the small bowel that is consistent with intra-mural hematoma

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Conflicts of interest

There are no conflicts of interest.

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