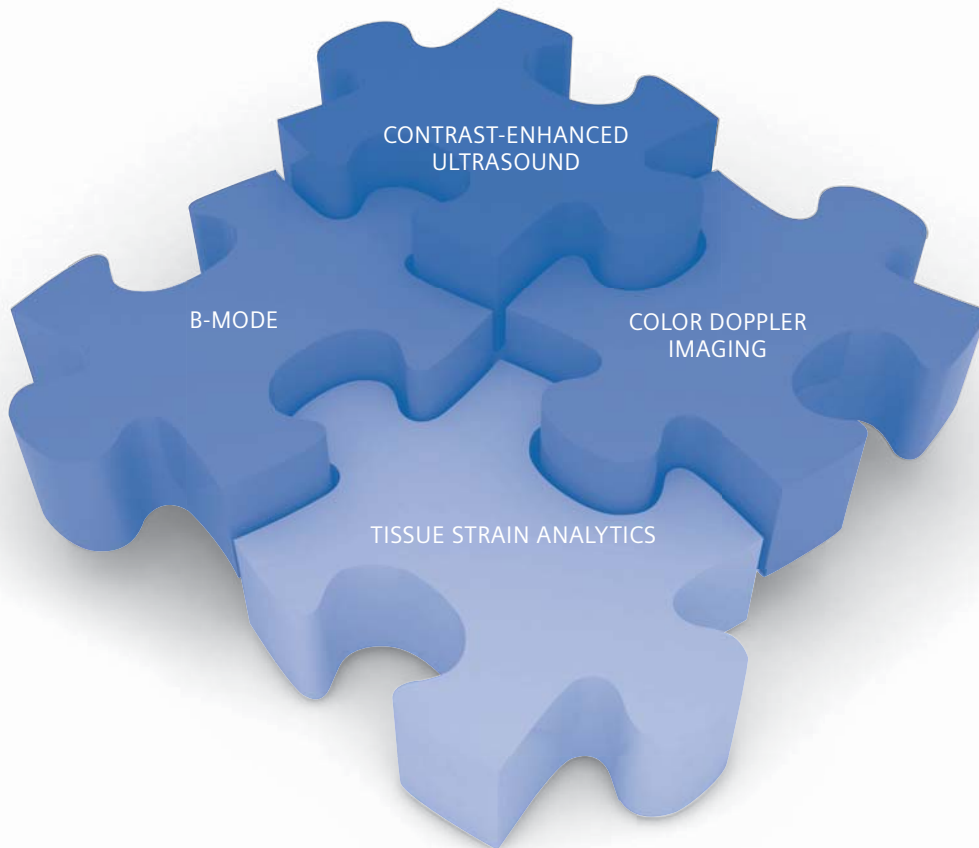
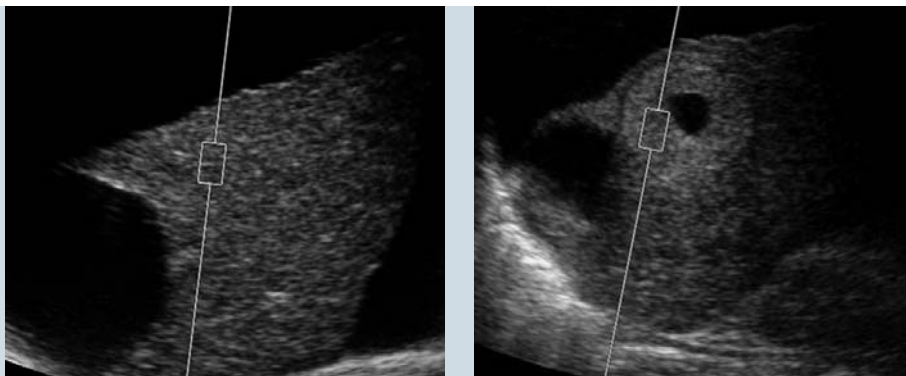


# Breakthroughs in Ultrasound Technology: Taking Imaging to the Next Level



Imagine being able to instantly find the missing pieces of a puzzle to help you get the full picture when it comes to improved confidence in tumor diagnosis. A physician in Calgary, Alberta, Canada, who specializes in imaging of the gastrointestinal tract, pancreas, and liver, is using unique Siemens ultrasound technology to do just that – combine the pieces Virtual Touch tissue analytics and contrast-enhanced ultrasound (CEUS) with conventional B-Mode and Doppler imaging.

By Amy K. Erickson



Left, an ARFI measurement from the liver of a 43-year-old patient with HBV is 2.4 m/second, consistent with a cirrhotic liver.

Right, an ARFI measurement from the mass is 1.3 m/second, consistent with a softer mass.

Stephanie Wilson, MD, a radiologist at Foothills Medical Center's Department of Diagnostic Imaging and a Clinical Professor in Radiology at the University of Calgary, offers her gastroenterology patients the highest cutting-edge care using the Siemens ACUSON S2000™ ultrasound system. In addition to traditional ultrasound applications, the multi-specialty system features unique implementations of qualitative and quantitative acoustic radiation force impulse (ARFI) strain imaging.

**"The ACUSON S2000 ultrasound system allows us to get really exquisite resolution of anything, from a mass in the liver to a small mass in the intestinal tract, to even smaller masses that might be common in the neck,"** says Dr. Wilson. **The system allows her "to make noninvasive diagnoses of liver masses and noninvasive evaluation of many other things in the body as well."**

Wilson says she and her team use the ACUSON S2000 system – which was installed about a year ago – all day, every day, to scan and diagnose patients in the clinic's four diagnostic rooms. "We see two major populations," notes Dr. Wilson. "We see patients who have liver disease or liver tumors. By liver disease, I mean cirrhosis and chronic liver disease, and by tumors, I mean liver cancer or benign liver disease. And we see those with

diseases of the gastrointestinal tract, especially inflammatory bowel disease."

### Tissue Strain Analytics

The ACUSON S2000 ultrasound system features a comprehensive range of tissue strain analytic applications that enable qualitative visual or quantitative value measurements of the mechanical stiffness or elasticity properties of tissue. The information provided by tissue strain analytics offers clinicians another diagnostic tool that can be used in conjunction with traditional ultrasound technology. For example, "The liver becomes stiffer as it goes from normal to cirrhotic," explains Wilson. "Therefore, the change in the stiffness over time may show a progression of the development of cirrhosis." Virtual Touch™ tissue imaging<sup>1</sup> from Siemens uses an acoustic "push pulse" to assess the stiffness of tissue, providing a qualitative grayscale map (elastogram) of relative stiffness for a defined region of interest.

Wilson notes that the ACUSON S2000 system allows radiologists to accurately isolate the position of the region of interest, so that it does not contain any blood vessels, connective tissue, or other

structures that might interfere with the scan. Once the area of interest has been identified, the push pulse is applied, which results in the relative displacement of tissue elements. The degree of displacement varies with the specific tissue properties. For example, soft tissue will experience greater displacement than very stiff tissue, which may displace a very small amount or not at all. Using this method, stiff tissue may be differentiated from soft tissue even if it appears isoechoic using conventional ultrasound imaging. Virtual Touch images provide complementary information to the standard B-mode image by supplying insights into changes in tissue stiffness, which are often associated with pathology.

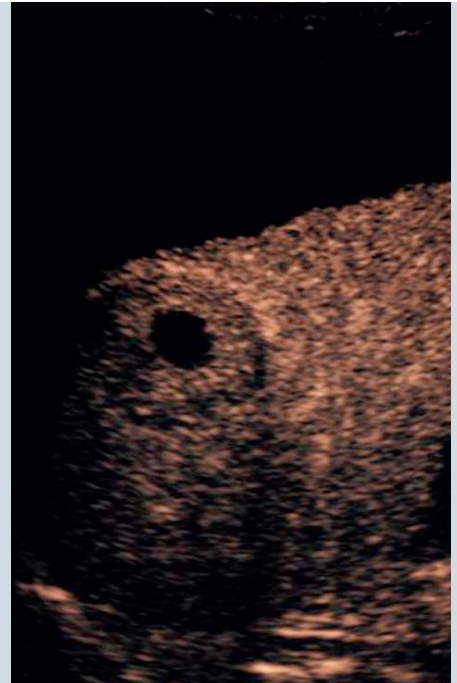
"With ARFI, we can see well into the body and look at tissue stiffness," says Wilson. Coupled with superior image quality and deep tissue imaging, other benefits include no manual compression and decreased interoperator variability. Furthermore, Virtual Touch tissue analytics offers liver patients a noninvasive diagnostic option. "Cirrhosis is traditionally diagnosed with the use of liver biopsy," says Wilson. "This is an invasive procedure, and sampling errors may influence the result. Therefore, measuring the stiffness with this technology hopefully will supply the same information as the biopsy. Virtual Touch tissue analytics is obviously noninvasive and, as we do multiple measurements, sampling errors are minimized."

Virtual Touch tissue imaging may also assist with determining the best therapeutic option to treat a liver tumor. Typically, says Dr. Wilson, therapy options include surgery, but only if the liver is noncirrhotic. If ARFI numbers indicate a normal liver, then surgery is a viable option for the treatment of the liver tumor. If ARFI indicates that a liver is cirrhotic, then surgery may be ruled out as an option, she says.

### Numerical Values

Another application of ARFI technology is the measurement of shear wave velocity via the Siemens Virtual Touch tissue quantification<sup>1</sup> application. Virtual Touch tissue quantification is the first and only

<sup>1</sup> Virtual Touch tissue imaging and Virtual Touch tissue quantification are not commercially available in the U.S.



Left, a sonogram of the same patient shows a small liver, ascites, and an echogenic mass with a hypoechoic center. Middle image shows arterial phase hypervascularity of the rim of the mass on CEUS. Right, in the portal venous phase, the mass shows washout, consistent with a malignant tumor. The use of CEUS and ARFI tells the “entire story” about the patient’s liver, cirrhosis with a malignant liver tumor, allowing for prompt initiation of his therapy.

## Achieving High-Resolution Images with Contrast-enhanced Ultrasound

In addition to acoustic radiation force impulse (ARFI) strain imaging, where tissue stiffness is imaged and quantified, contrast-enhanced ultrasound (CEUS)<sup>1</sup> gives radiologists the ability to image blood perfusion and microvascular details in organs such as the liver. Both contrast-enhanced ultrasound and Virtual Touch tissue analytics technologies are supported by the Siemens ACUSON S2000™ ultrasound system.

Contrast-enhanced ultrasound is performed by injecting microbubble contrast agents into a peripheral vein. The microbubbles remain in the systemic circulation for a certain period of time. During that time, ultrasound waves are directed at the region of interest. “The contrast agents respond and interact with the

ultrasound beam and allow us to produce images related to their oscillations,” says Dr. Stephanie Wilson. Because microbubble contrast agents behave nonlinearly, the signal-to-noise ratio is increased, resulting in better visualization of blood vessels and organs throughout the body.

### Diagnosing Liver Masses

At the Foothills Medical Center, Dr. Wilson primarily uses contrast-enhanced ultrasound to characterize focal liver masses. “Many liver masses, notably hepatocellular carcinoma or primary liver cancer, are found in patients with chronic liver disease or cirrhosis. In these situations, ARFI may provide information about the background liver – that is, is it cirrhotic or not – and contrast-enhanced ultrasound may provide the diagnosis of the liver mass,” says Wilson. The noninvasive aspect of this technique is a huge benefit, she adds.

Many experts believe that contrast-enhanced ultrasound is a revolutionary

expansion to the performance of ultrasound worldwide. “It is a sensational technique that has unlimited potential to improve patient care and patient diagnoses,” says Wilson. “It is complementary to CT [computed tomography] and MRI [magnetic resonance imaging] scans for liver mass diagnosis and provides non-invasive, excellent diagnosis without the requirement for ionizing radiation. Contrast-enhanced ultrasound is also used in many other organs beyond the liver with similar benefits.”

The Siemens ACUSON S2000 ultrasound system combines Virtual Touch tissue applications with Cadence™ contrast pulse sequencing technology<sup>1</sup> to further improve diagnostic confidence by assessing not only the stiffness, but also vascularity of a lesion, which can be an indicator for malignancy. “This is a good idea,” says Dr. Wilson. “I like the system very much. It has great B-Mode and color Doppler, and the additional benefits of contrast ultrasound and ARFI.”

<sup>1</sup> At the time of publication, the U.S. Food and Drug Administration has cleared ultrasound contrast agents only for use in LVO. Check the current regulation for the country in which you are using this system for contrast agent clearance. Not commercially available in the U.S.

application to provide a numerical value to shear wave speed related to tissue stiffness at a location in the body. This speed can be accurately measured and is considered an intrinsic and reproducible property of tissue.

Shear waves, which travel at greater speeds in stiff tissue compared to soft tissue, disperse perpendicular to the push pulse. Unlike conventional ultrasound waves, shear waves are attenuated approximately 10,000 times more rapidly and require greater sensitivity to measure. As the shear wave front travels through tissue, the displacements generated by the wave are detected using ultrasound tracking beams. Measuring the wave front at several locations and correlating these measurements with the elapsed time quantifies the shear wave speed.

“As sonographers, [much of what] we do is based on how the image looks,” says Wilson. “Our work is exceptionally qualitative as opposed to quantitative. So what Virtual Touch tissue quantification adds is an actual quantitative evaluation of the how stiff the tissue is.”

The application is simple to use, Wilson explains, “Once the area of interest is located, we have the patient suspend respiration for only about five seconds while we initiate the pulse. In a fraction of a second, [the ACUSON S2000 system] comes up with a measurement of the shear wave velocity, so we can tell not only that, but also how stiff the liver is.” She adds, “It provides additional non-invasive information that is based on

something different than traditional ultrasound.”

### Routine Surveillance

The ACUSON S2000 ultrasound system can also provide value to patients who are undiagnosed, but at risk for liver cancer. Wilson points out that it is very simple to add in the ARFI applications if a patient is already coming in on a regular basis for a liver surveillance scan. “The management of those patients is entirely improved by doing that one-stop shopping provided by the ACUSON S2000 system,” says Dr. Wilson. “If the patient comes in for his or her six-month surveillance scan and a new nodule is found, then we can determine right there if it is significant or not significant by performing CEUS of the mass at the time of its detection. [This information] directs what subsequently happens to that patient.” In cases where an incidental liver mass is found, notes Wilson, it is beneficial to be able to characterize the mass with a noninvasive, nonradiation technique without having to impose more tests on the patient.

Dr. Wilson believes that together with the identification or diagnosis of liver tumors and cirrhosis, this kind of high-end ultrasound technology “may also in the future play a role in cancer diagnosis, as malignant tumors are often stiffer or harder than benign tumors.”

*Amy K. Erickson is a freelance health and medical journalist based in San Francisco, California, USA.*

## Summary

### Challenge:

- Noninvasively diagnosing patients who are at risk for cirrhosis, liver disease, and liver tumors
- Obtaining quantitative measurements of tissue stiffness for identification and diagnosis of abnormalities
- Supplementing conventional B-Mode sonography, which provides anatomical detail based on differences in acoustic impedance, yet may not yield enough information to make a diagnosis
- Being able to perform noninvasive, precise imaging of vasculature in the heart and other organs
- Identifying problems early in patients who are at risk for liver disease

### Solution:

- Virtual Touch tissue imaging and Virtual Touch tissue quantification applications using ARFI technology to provide both qualitative and quantitative information on the stiffness of tissue, often related to pathology
- Contrast-enhanced ultrasound, using microbubble contrast agents that allow clinicians to image tissue vasculature

### Result:

- Fast, nonirradiating examination providing valuable information about morphology and mechanical properties of tissue to facilitate diagnosis and treatment
- Increased diagnostic confidence to provide more individualized patient care
- Early detection and identification of incidental abnormalities when elasticity properties are a part of a patient’s regular surveillance liver exam

“Contrast ultrasound is a sensational technique that has unlimited potential to improve patient care and patient diagnoses.”

Stephanie Wilson, MD, Department of Diagnostic Imaging, Foothills Medical Center, Clinical Professor in Radiology, University of Calgary, Alberta, Canada

### Further Information

[www.siemens.com/strain](http://www.siemens.com/strain)