Tissue Strain Analytics – A Breakthrough for Ultrasound Liver Examinations

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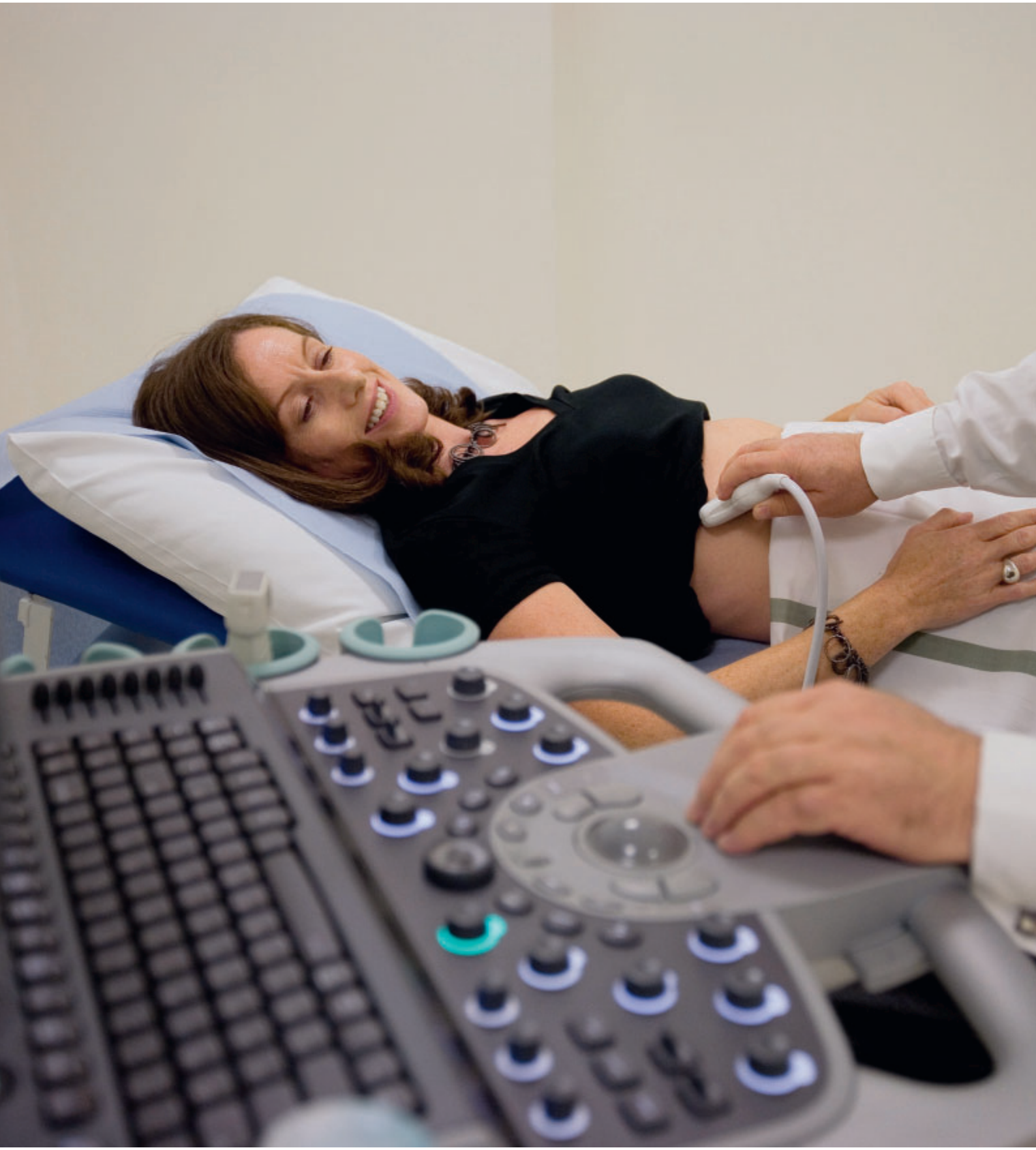
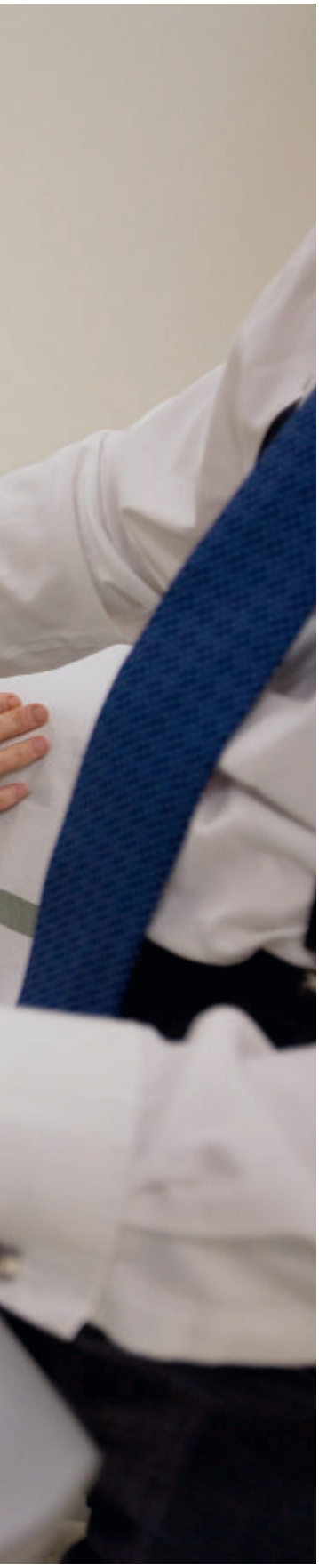




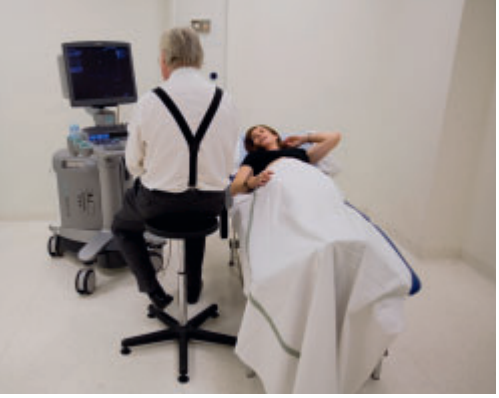
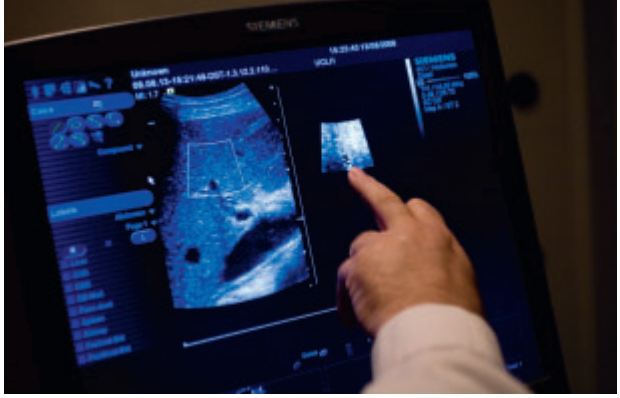
Tissue Strain Analytics – A Breakthrough for Ultrasound Liver Examinations

A new era is dawning for quicker, more accurate diagnoses of pathologies in the liver, thanks to a research partnership between The University College London Hospital and Siemens Healthcare.

By Nils Lindstrand

A member of the Siemens Healthcare Ultrasound Research Advisory Board, Professor William Lees, MD, of the University College London Hospital (UCLH), UK, started researching the clinical potential of ultrasound Acoustic Radiation Force Impulse (ARFI) imaging about one year ago. He soon realized that this technology might be a way to increase the clinical diagnostic information that results from conventional sonographic examinations. "Tissue Strain Analytics[1] adds an independent parameter to our existing morphological diagnostic process. No single parameter is going to enable us to characterize tissue with any degree of accuracy, but the more parameters we have, the more confident our diagnosis can be," says Lees of the emerging application. Virtual Touch™ Tissue Imaging[1], the first commercially available implementation of ARFI, uses an acoustic 'push pulse' to interrogate the mechanical strain prop-

[1] This product is not commercially available in the U.S.


A member of the Siemens Healthcare Ultrasound Research Advisory Board, Professor Dr. Lees examines the capabilities of Virtual Touch Tissue Imaging and Quantification in liver fibrosis.

Summary

Challenge:

- Obtain qualitative visual or quantitative value measurements of the mechanical stiffness properties of tissue

Solution:

- Tissue Strain Imaging allows visualization of differences in the stiffness of tissues and pathologies that may otherwise appear very similar using conventional ultrasound imaging
- Tissue Strain Imaging has the potential for immediate results
- Tissue Strain Imaging is user-independent

Result:

- Virtual Touch applications, together with conventional sonographic scans, may enable physicians to avoid unnecessary biopsies
- Grey scale image presents a map of regions and localized areas which shows relative stiffness in the tissue
- Numeric value provides a good understanding of the general condition of the tissue

erties or stiffness of tissue, a method similar to a physical palpation exam. 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.

A Virtual Touch image is formed by applying a push pulse, which results in the relative displacement of tissue elements. The degree of displacement will vary with the specific stiffness properties. For example, soft tissue will experience greater displacement than very stiff tissue, which may displace a very small amount or not at all. Conventional ultrasound beams track the displacement of tissue. This information is compared to the baseline image, resulting in a qualitative elastogram, which visually represents the variation in stiffness within a region of interest.

Today, this technology is only available by Siemens with the ACUSON S2000™ ultrasound system. "Virtual Touch Tissue Imaging is an important evolution of the ultrasound scanning technologies," says Lees. "The technology works, it is reliable and robust. Virtual Touch Tissue Imaging has a minimal impact on the tissue, yet it has the ability to extract an impressive amount of vital information out of a single procedure."

Breakthrough for Liver Examinations

Another application of ARFI technology is the measurement of shear-wave velocity. This is implemented by Virtual Touch Tissue Quantification[1]. Shear waves, which travel at greater speeds in stiff tissue compared with soft tissue, are generated, and travel perpendicular to the push pulse. While they do not interact directly with the transducer, their movement may be tracked by detecting tissue displacement perpendicular to the transmitted, conventional ultrasound beam.

"It is like hitting a board on the upside and feeling the effect at the ends," says Lees, "only with an extremely high accuracy in the measurement." Virtual Touch Tissue Quantification may prove to be a major breakthrough in identifying early stages of liver diseases causing cirrhosis. In early studies, the application proved extremely sensitive in diagnosing fibrosis and distinguishing it from normal liver and cirrhosis. Conventional ultrasound, on the other hand, cannot detect fibrotic changes prior to cirrhosis. "We will need more data to determine whether this new technology is also capable of tracking progression of fibrosis or responses to treatment, but I am very optimistic that it will have this capability," says Lees.

The robustness of Virtual Touch applications is an important advantage of this method. "We have been examining obese patients during the clinical studies already completed, and Virtual Touch Imaging showed very good accuracy," says Lees.

[1] This product is not commercially available in the U.S.

Lees stresses the advantage of Virtual Touch applications as a user-independent method. "Both with traditional physical palpations and preceding ultrasound technologies, it is easier than you would imagine for a physician to press harder to get the result he or she was expecting before the examination. With Virtual Touch applications, however, it is just pushing a button. You get the same accuracy every time, regardless of the operator, time, or expectations."

A Way to Avoid Unnecessary Biopsies

Virtual Touch applications may offer a way to reduce unnecessary biopsies and other invasive procedures otherwise needed to give an accurate diagnosis through easy evaluation of pathology. "These kinds of anomalies may be difficult to separate from malign tissue with other kinds of scanning technologies," says Lees. "This is typical of how Virtual Touch Imaging is helping us: We can avoid many biopsies and other uncomfortable and unnecessary examinations."

Using this technology together with conventional sonographic scans and traditional biochemical examination, physicians may also be able to give a more reliable answer whether a pathology is malignant or benign.

"I believe Virtual Touch applications will be an integral part of scanning procedures in the near future," says Lees. "Our clinical tests up until now have shown a very high accuracy in separating malignant, benign, and healthy tissue. The method is quick and user-independent, and is totally unnoticeable for the patient."

More Validation Needed

"My present experience today is built on more than 200 cases," says Lees, "and it indicates that Virtual Touch applications can detect fibrosis in an otherwise normal-appearing liver." Now this needs to be validated against liver biopsy and biochemical testing for chronic liver disease. Experience shows that up to a thousand validated cases may be needed to be able to define its role. Lees is convinced that Virtual Touch applications offer improved patient care on an individual basis. Physicians will be able to tell patients that they have nothing to worry about, or to proceed faster to additional examinations and treatment if this proves necessary. "The benefit of Virtual Touch applications is that we can be more convinced of doing the right things and giving correct information to the patient."

Lees and the UCLH are now organizing clinical tests for Virtual Touch applications, collaborating with a number of other clinics and hospitals in Great Britain. They will start as soon as the last details in the methodology are established and agreed upon. "We should be able to conduct these clinical tests within a couple of months," says Lees. "We have already submitted an abstract to the European Congress of Radiology 2009 on Virtual Touch applications, and I think it will be sufficiently validated for wider clinical application towards the end of 2009."

The interest for Virtual Touch applications has so far largely been confined to the liver. It may, however, prove to be a valuable tool also in examinations of other organs, for example, the kidneys and thyroid and maybe the lung. It will probably not work as well in rapidly moving structures such as the heart and vascular system. "Apart from this, we will need to establish a much larger database of Virtual Touch Tissue Quantification measurements in other diseases of organs," says Lees. "I think it will be another year or two before we fully understand the potential of this technology."

Nils Lindstrand *is a freelance business and technology writer based in Stockholm, Sweden.*

Further Information

www.siemens.com/strain

Tissue Strain Analytics at a Glance

Tissue Strain Analytics is a new ultrasound application that enables visual or numerical measurements of the mechanical stiffness of tissue. This new dimension of information, which is not available using conventional sonographic imaging, represents the most significant advancement in ultrasound technology since the advent of Doppler imaging. Tissue Strain Analytics features three applications:

- Virtual Touch Tissue Imaging allows clinicians to create a relative stiffness map (elastogram) for any region of interest.
- Virtual Touch Tissue Quantification is the first and only application to provide a numerical value of shear-wave speed related to tissue stiffness at a precise anatomical location.
- eSie Touch™ elasticity imaging, available on both the ACUSON Antares™ and ACUSON S2000 systems, enables high-resolution elastography using both superficial and endocavity transducers.

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