診斷超音波簡介

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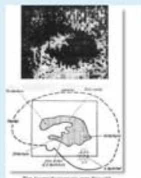
1942: Karl Dussik, Neurologist and Psychiatrist at the University of Vienna, generally regarded as the first physician to use ultrasound for medical diagnosis (of brain tumors)

Karl Theo (Theodore) Dussik
1908 - 1968

Dussik and his ultrasonic apparatus in 1946



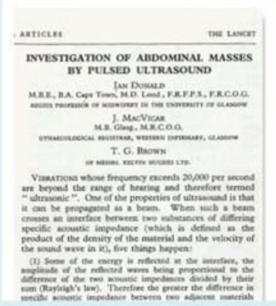
The hyperphonogram was thought to depict the ventricles

1948: George Ludwig M.D.,- Internist first described the use of ultrasound to diagnose gallstones

George D. Ludwig
1922 - 1973

Ludwig, G.D. and Struthers, F.W. Considerations underlying the use of Ultrasound to detect Gallstones and Foregn Bodies in Tissue. Naval Medical Research Institute Reports, Project #004 001. Report No. 4. June 1949.

1958: Ian Donald Pioneers OB-GYN Ultrasound (Obstetrics and gynecology)



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INVESTIGATION OF ABDOMINAL MASSES BY PULSED ULTRASOUND

IAN DONALD
M.B.E., B.A. Cape Town, M.D. Lond., F.R.F.P.S., F.R.C.O.G.

J. MACVICAR
M.B. Glasg., M.R.C.O.G.

T. G. BROWN

VIBRATIONS whose frequency exceeds 20,000 per second are beyond the range of hearing and therefore termed "ultrasonic". One of the properties of ultrasound is that it can be propagated as a beam. When such a beam crosses an interface between two substances of differing specific acoustic impedance (which is defined as the product of the density of the material and the velocity of the sound wave in it), five things happen:

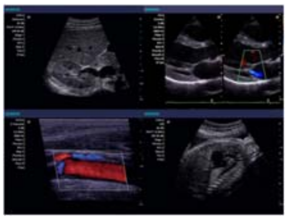
(1) Some of the energy is reflected at the interface, the amplitude of the reflected waves being proportional to the difference of the two acoustic impedances divided by their sum (Rayleigh's law). Therefore the greater the difference in specific acoustic impedance between two adjacent materials

1950s: Douglass Howry & Joseph Holmes pioneer 2D B-mode Ultrasound at the Univ. of Colorado

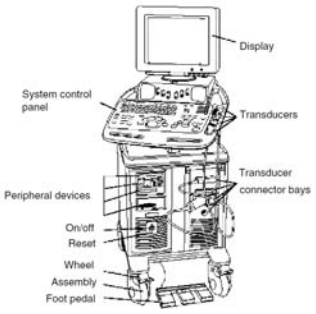
Joseph H Holmes
1902 - 1982

The pan-scanner in 1957

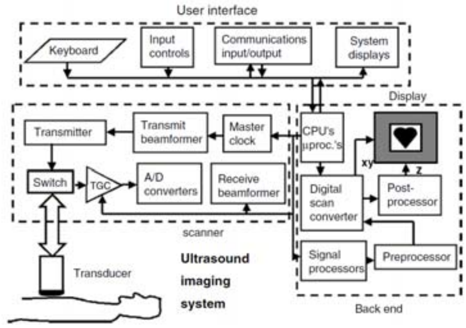
Diagnostic ultrasound imaging



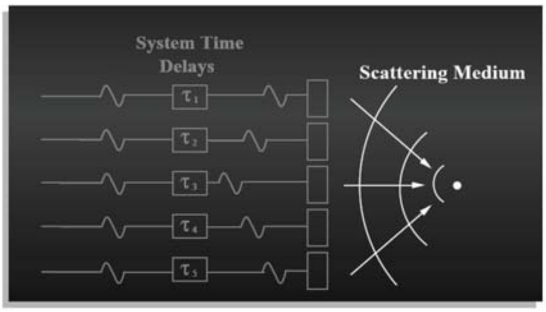
Ultrasound imaging system



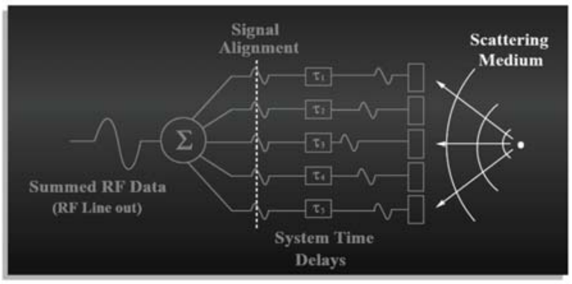
A simple block diagram



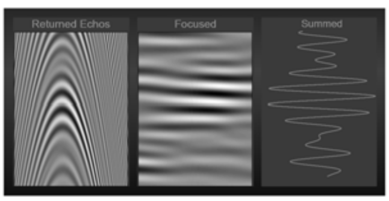
Transmit beamformer

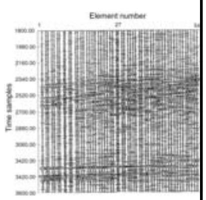


Receive beamformer

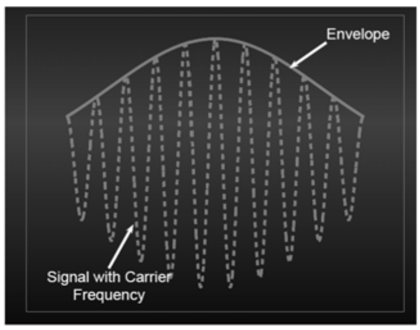


Beamformed RF signals

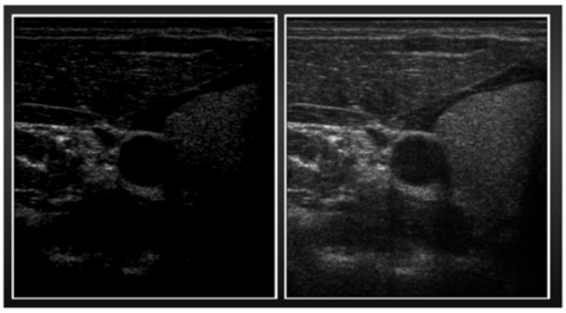




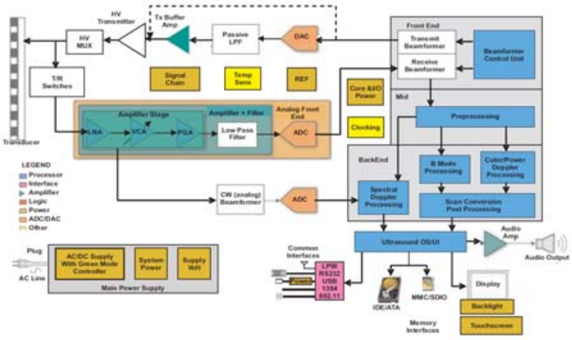
Envelope detection



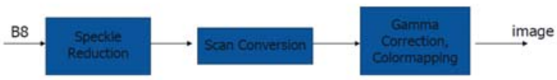
Compressed envelope image



System block diagram



B-mode image



Analogic Ultrasound Group

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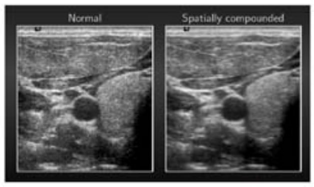
Spatial compounding

- Multiple images of the same target are averaged to improve the image.
- Many ways to obtain uncorrelated speckle patterns:
  - Change the steering angle of the beams
  - Change the transmit frequency



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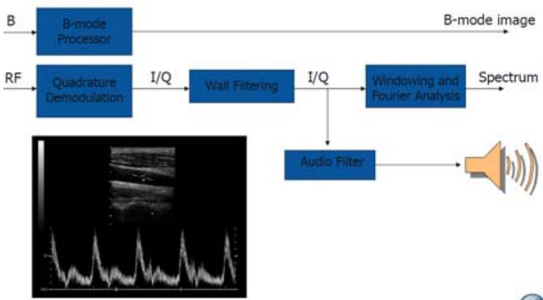
Power Doppler imaging



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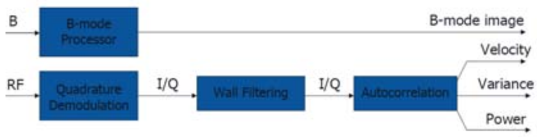
Color flow imaging



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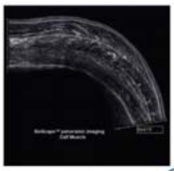
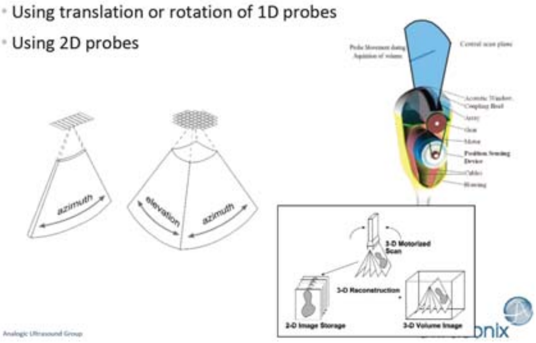
Panoramic imaging

- Allows real-time acquisition and display of B-mode panoramic images.
- Large organs and long vessels can be displayed in their full dimension for increased on-screen anatomical information.

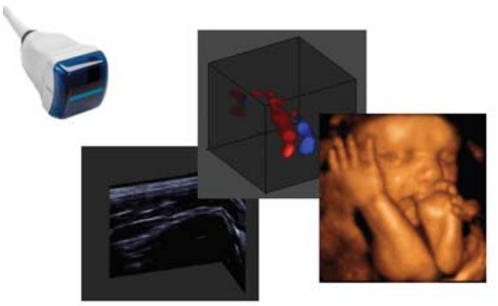


3D ultrasound

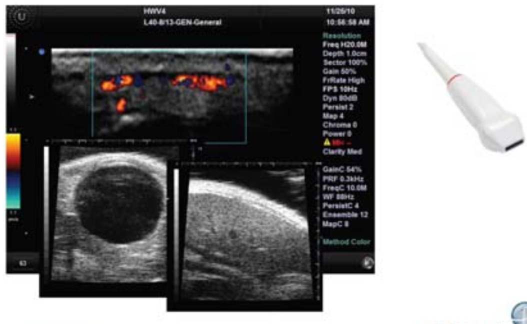
- Using translation or rotation of 1D probes
- Using 2D probes



3D/4D imaging

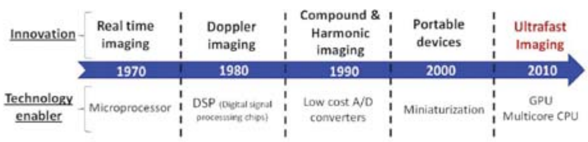


High-frequency imaging

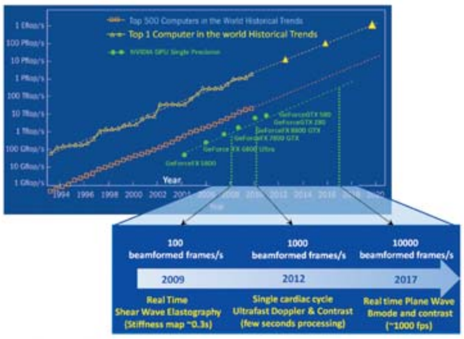


Ultrafast imaging

Innovations and their technological enablers

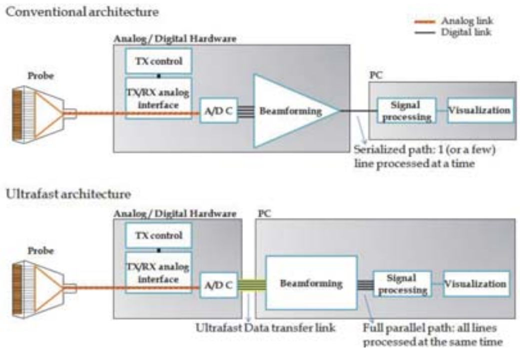


Moore's law and its impact on ultrasound techniques

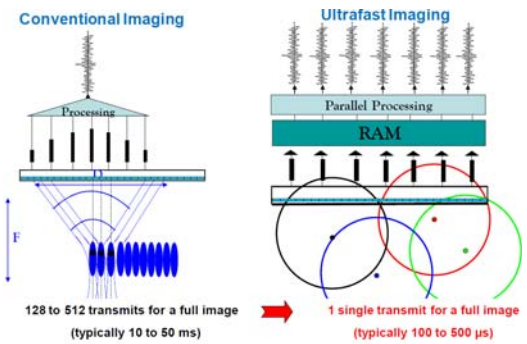


摩爾定律是指IC上可容納的晶體管數目，約每隔18個月便會增加一倍，性能也將提升一倍。

Ultrafast architecture



Ultrafast imaging



Plane wave compounding

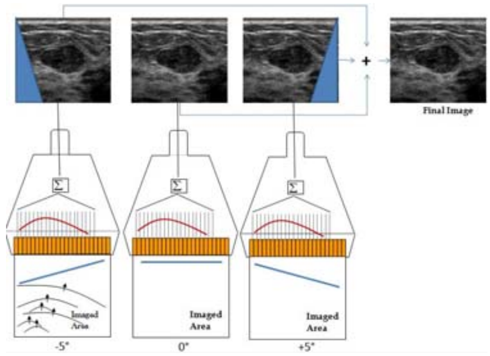
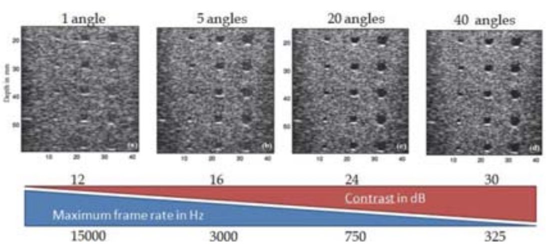
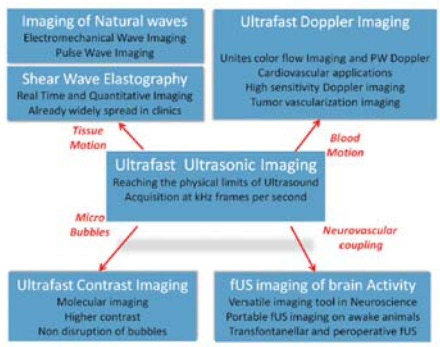


Image quality as a function of the number of angles

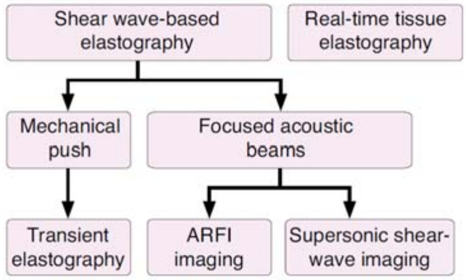


Applications of ultrafast imaging

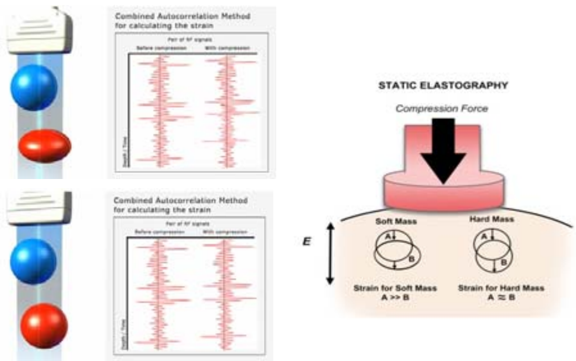


Elastography

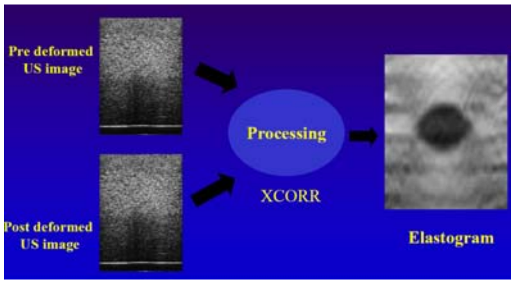
Types of elastography



Principle of real-time elastography



Real-time elastography formation



Types of real-time elastography

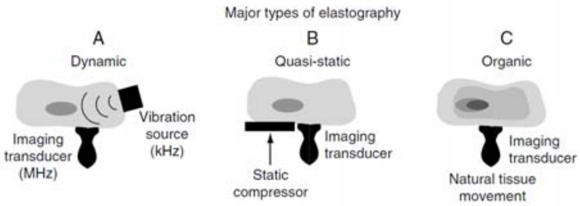
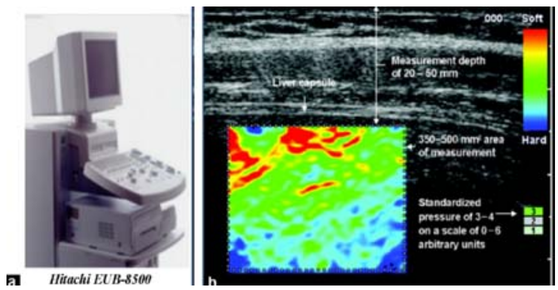
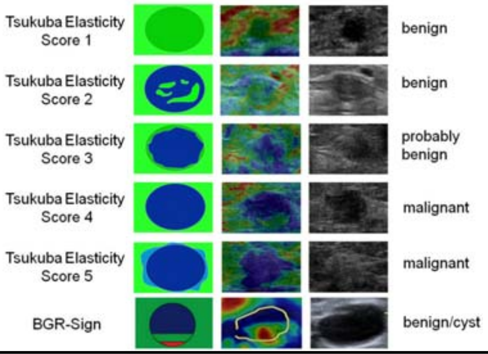


Figure 9.27 Main types of elastography: (A) sonoelasticity, (B) quasistatic, and (C) organic.

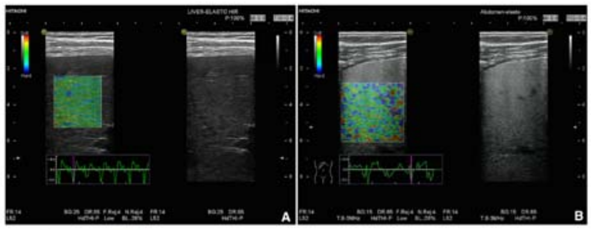
Real-time elastography



Strain image for breast tumor classification

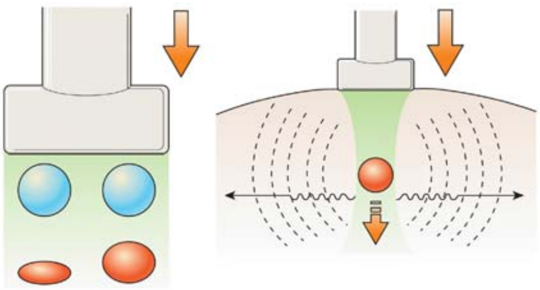


Strain image for liver fibrosis detection

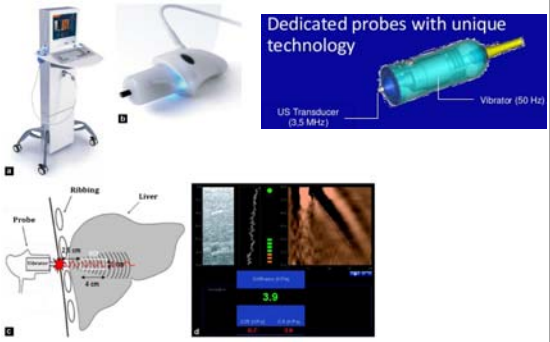


Strain elastography in a healthy liver (**A**) and in a liver with moderate fibrosis (**B**). *Images courtesy of Hitachi Aloka Medical.

From qualitative to quantitative



Transient elastography



Transient elastography of liver cirrhosis

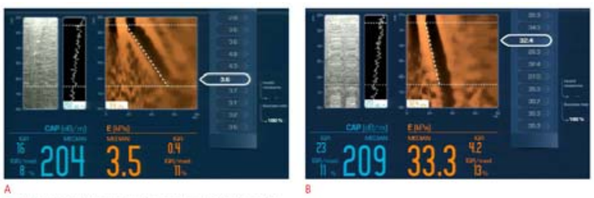
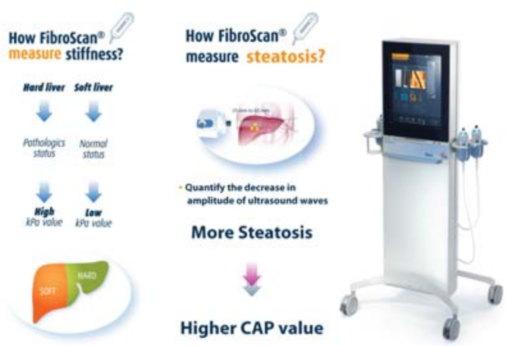
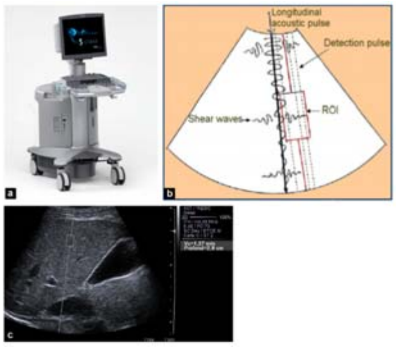


Fig. 3. **Transient elastography of a normal and a cirrhotic patient.**
The displacement M-mode image located in the center of the monitor shows axial displacement as a function of depth (y-axis) and time (x-axis). In the healthy patient (A), the shear wave is relatively slow and the liver stiffness is low. However, in the patient with cirrhosis (B), the shear wave can propagate more rapidly though a hard tissue, and the time-depth gradient is very steep. The controlled attenuation parameter is displayed, which is known to correlate with the fatty liver severity (Courtesy of Dr. Yong Han Paik, Department of Internal Medicine, Samsung Medical Center, Seoul, Korea).



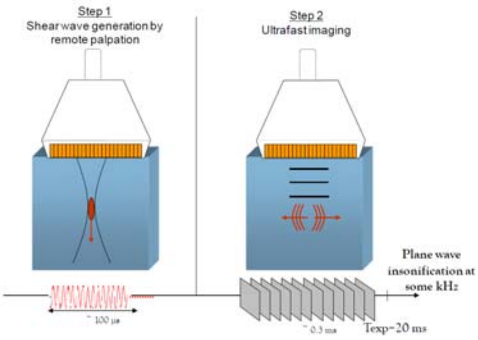
Acoustic radiation force imaging (ARFI)

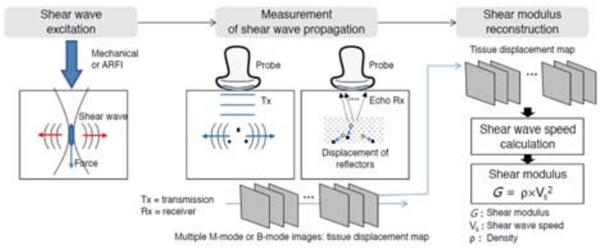


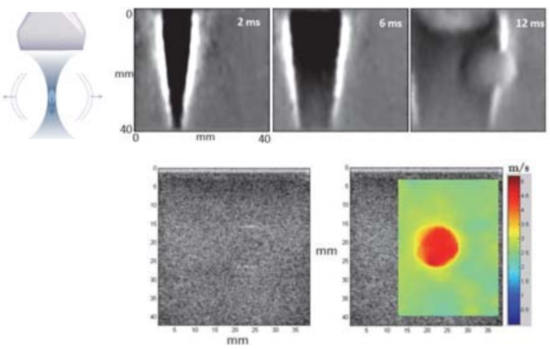
ARFI of liver cirrhosis

Fig. 4. Acoustic radiation force impulse imaging of a normal and a cirrhotic patient.
The cylindrical region of interest (ROI) in the middle of the ultrasonogram was used as the sample volume for the measurement of stiffness. Instead of Young modulus, the propagating velocity of the shear wave is displayed. Although the grayscale ultrasonograms are similar to each other, the propagating velocity is different: 1.2 m/sec in the healthy patient (A) and 1.6 m/sec in the patient with cirrhosis (B) (Courtesy of Dr. Yong Eun Chung, Department of Radiology, Severance Hospital, Seoul, Korea).

Shear wave elastography







Shear wave elastography of liver cirrhosis

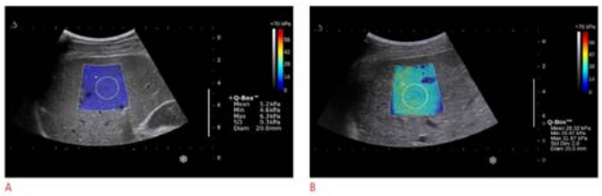


Fig. 5. Supersonic shear-wave imaging of a normal and a cirrhotic patient.
A large trapezoidal color box display of the distribution of the elastic properties of the liver. The severity of stiffness is depicted with the colored look-up table. Dark blue color represents normal liver tissue (A), and bright blue-green color represents increased liver stiffness such as liver cirrhosis (B). The round region of interest (ROI) in the color box is the Q-Box and the mean Young modulus and standard deviation in the ROI have been calculated.