

Liver fibrosis

Bernard Van Beers

Department of Radiology

Hôpital Beaujon

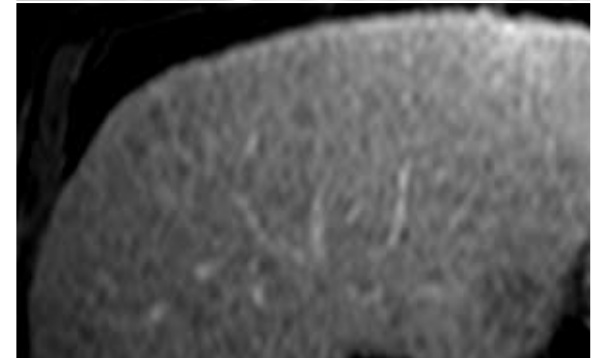
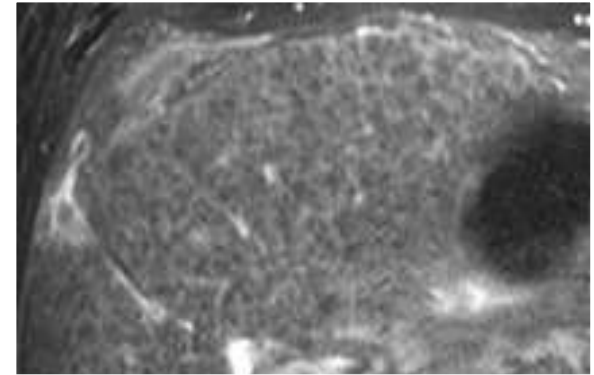
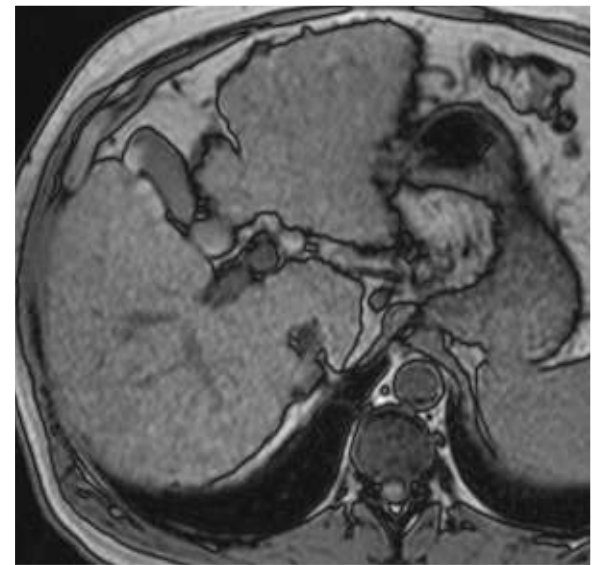
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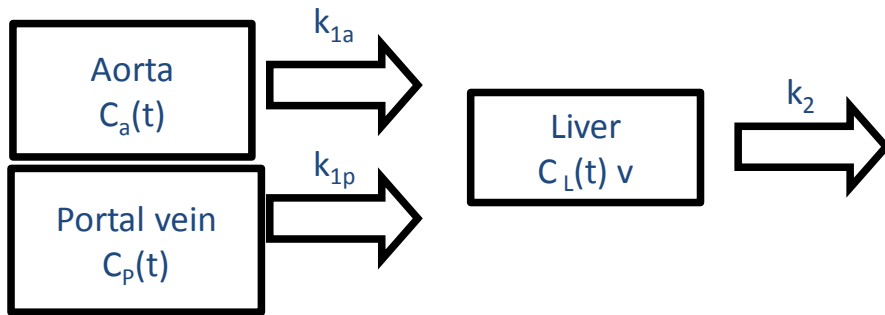
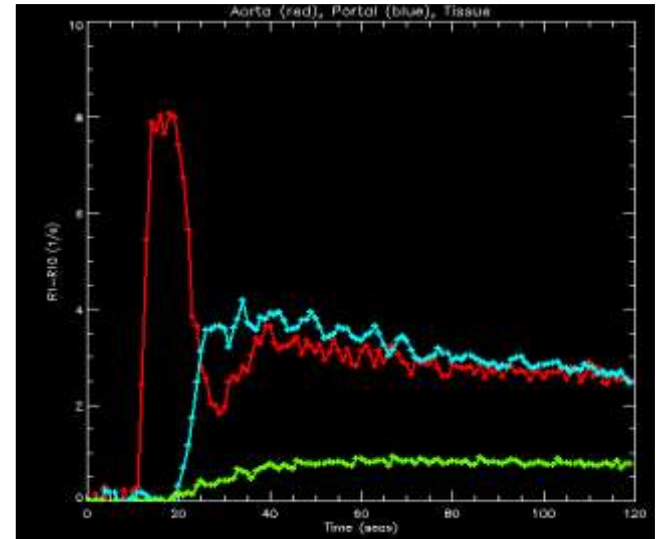
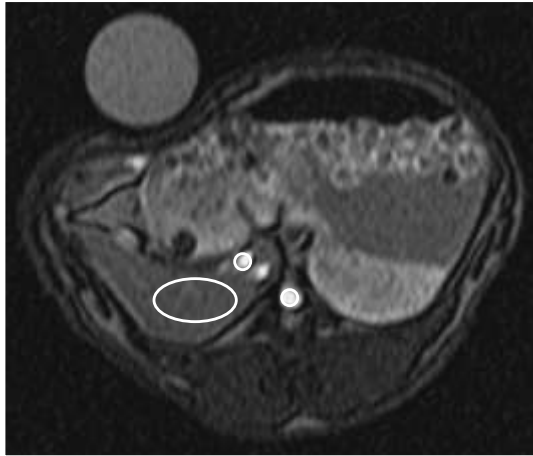


Morphological signs

- Liver with nodular contours
- Atrophy, hypertrophy
- Fibrosis
 - Hyperintense on T2-w images
 - Hypointense on T1-w images
 - Hyperintense on delayed gadolinium-enhanced images and iron oxide-enhanced images
 - Double-contrast MRI: sensitivity and specificity > 90% to differentiate between F0-F2 and F3-F4

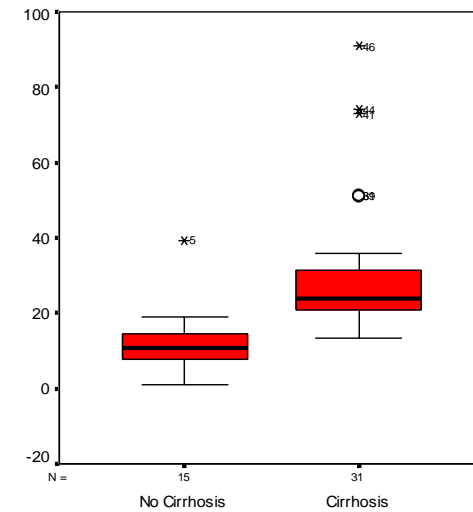
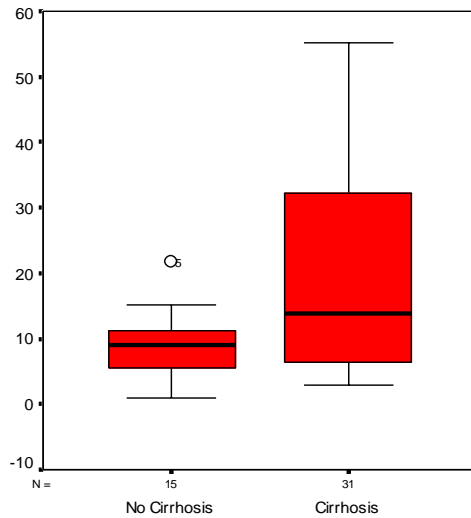
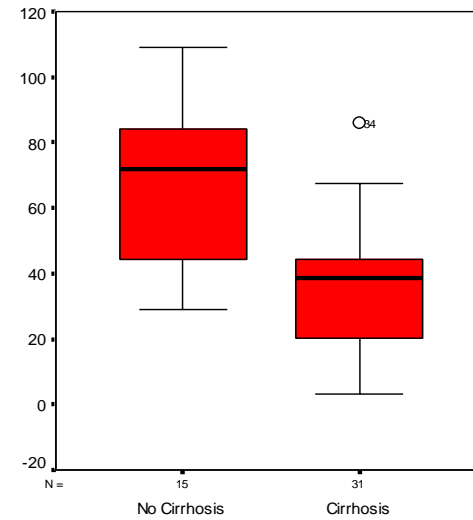
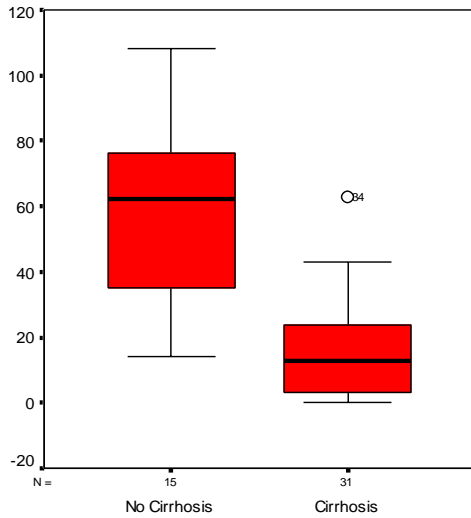


Perfusion imaging



- Arterial perfusion: k_{1a}
- Portal perfusion: k_{1p}
- Total liver perfusion: $k_{1a} + k_{1p}$
- Distribution volume: k_1/k_2
- Mean transit time: $1/k_2$

Perfusion parameters in patients with liver cirrhosis

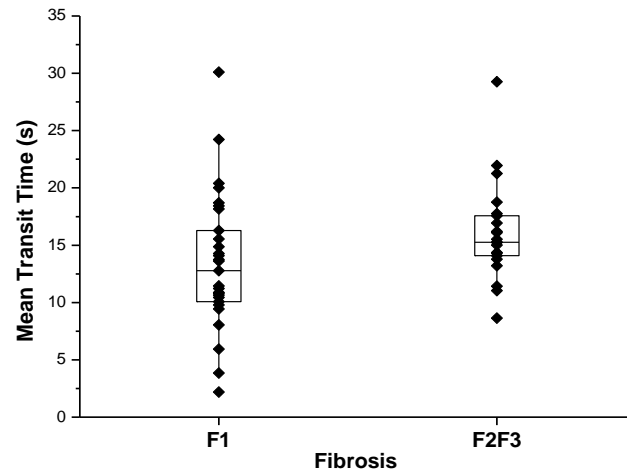
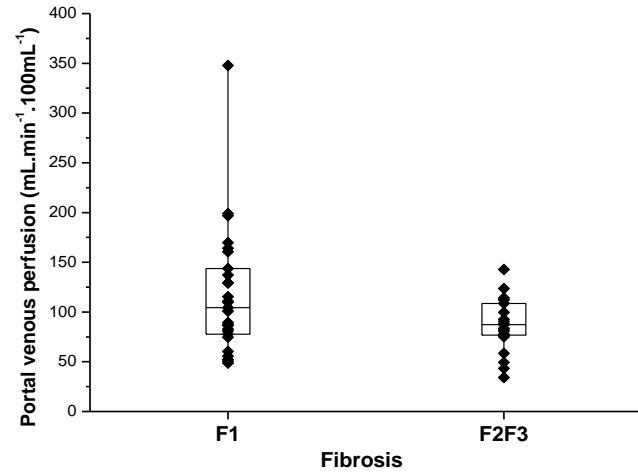


Annet L et al. Radiology 2003; 229:409-414
Van Beers BE et al. Magn Reson Med 2003; 39:692-699

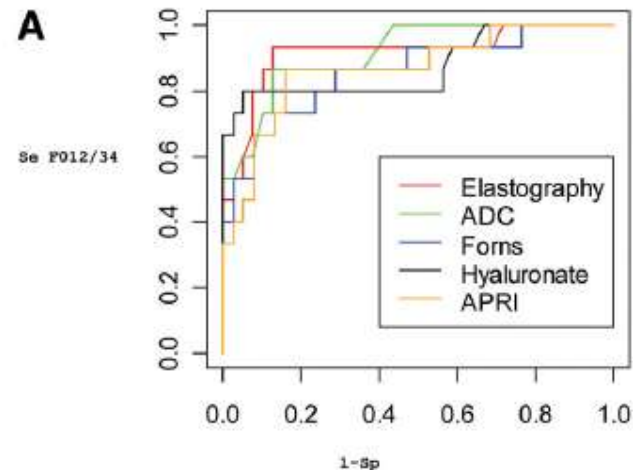
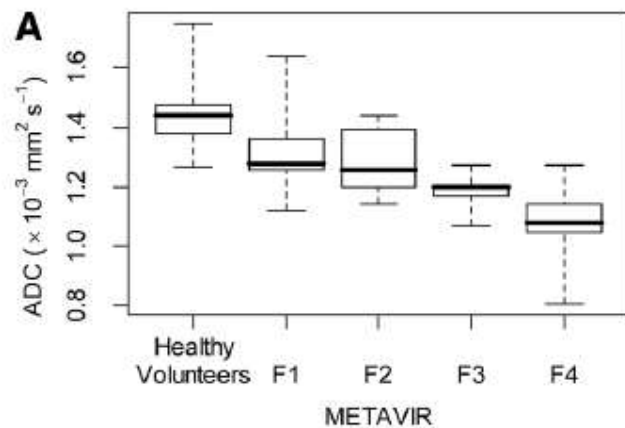
DCE-CT in liver fibrosis

Decrease portal venous and total liver perfusion in F2-3 versus F1

Increase in mean transit time



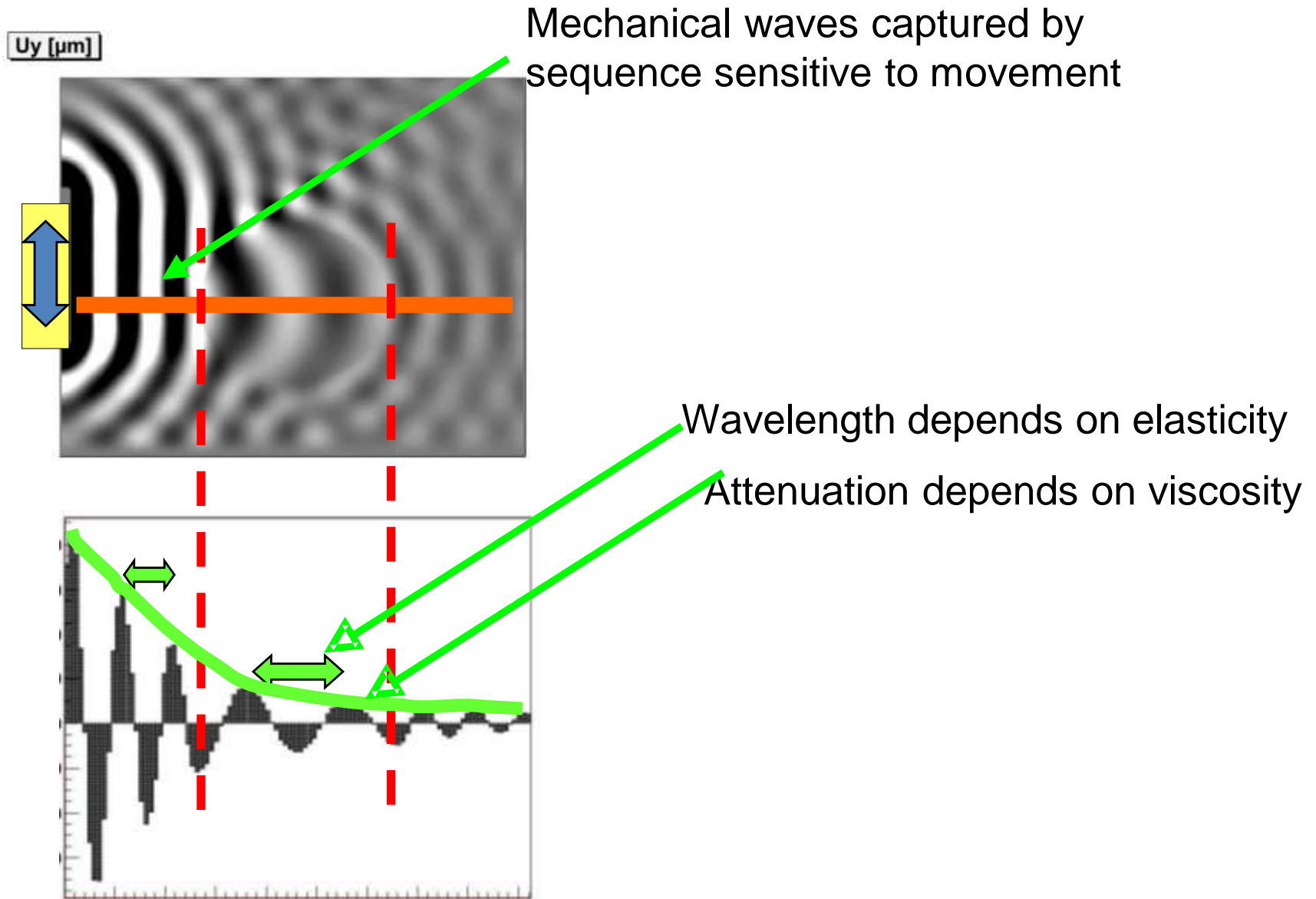
DWI in liver fibrosis



- Comparison
 - Diffusion MRI
 - Fibroscan
 - Blood biomarkers

Taouli B et al. Radiology 2003;226:71-78
Lewin M et al. Hepatology 2007;46:658-665

Dynamic elastography

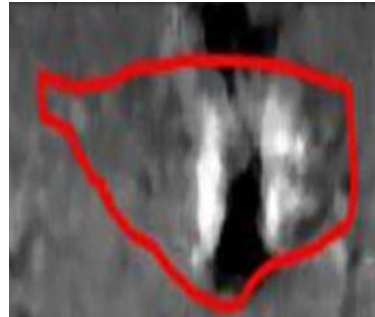


Dynamic elastography

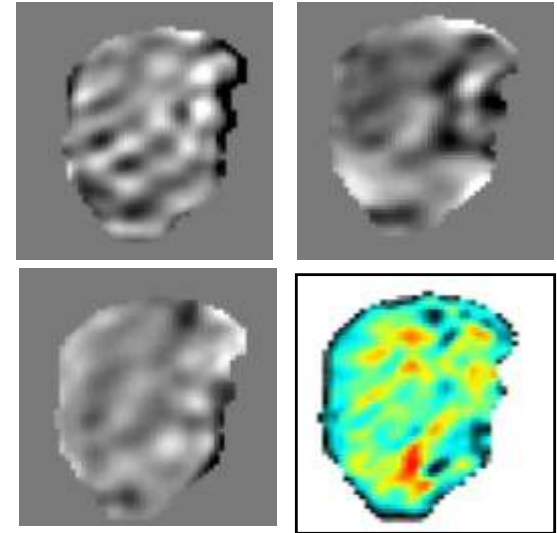


Fibroscan
1D

Low penetration



ARFI
2D

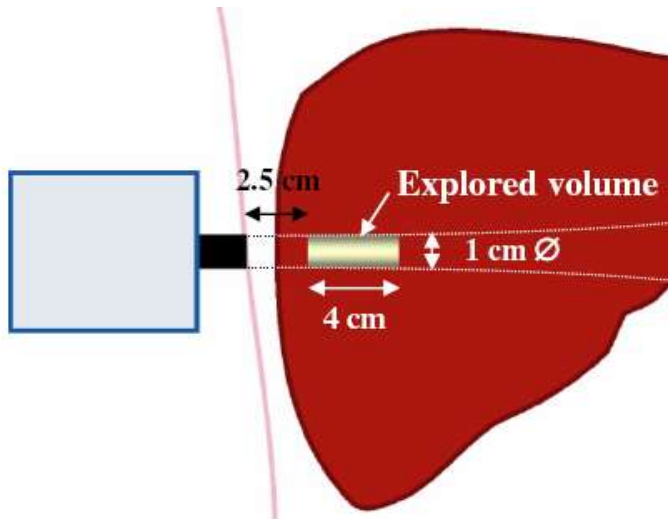


MRE

3D: visco-elasticity
Good penetration

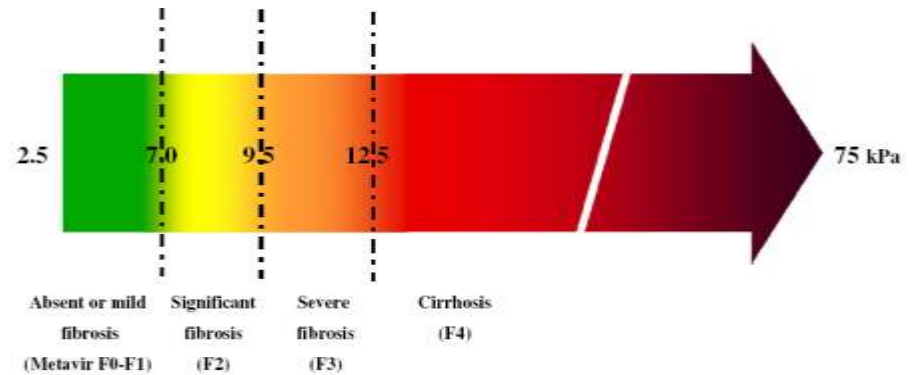
Sandrin L et al. IEEE Trans Ultrason Ferroelec Freq Control 2002; 49: 436-446
Bercoff J. et al. IEEE Trans Ultrason Ferroelec Freq Control 2004; 51: 396-409
Sinkus R et al. Magn Reson Imaging 2005; 23: 159-165

Fibroscan

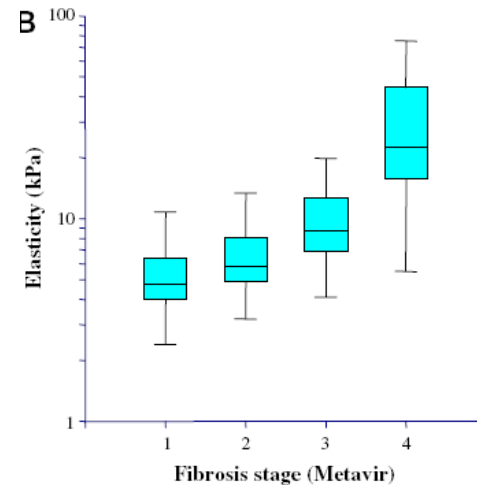


- Dedicated system
- Small volume
- Easy to perform
- No ultrasound image

Results of Fibroscan



- Staging
 - Significant fibrosis
 - AUROC 0.80 – 0.85
 - Cirrhosis
 - AUROC 0.90 – 0.95

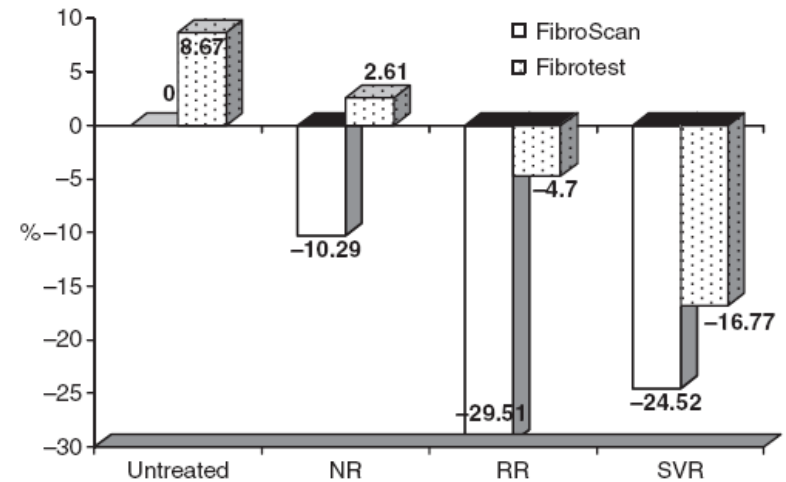
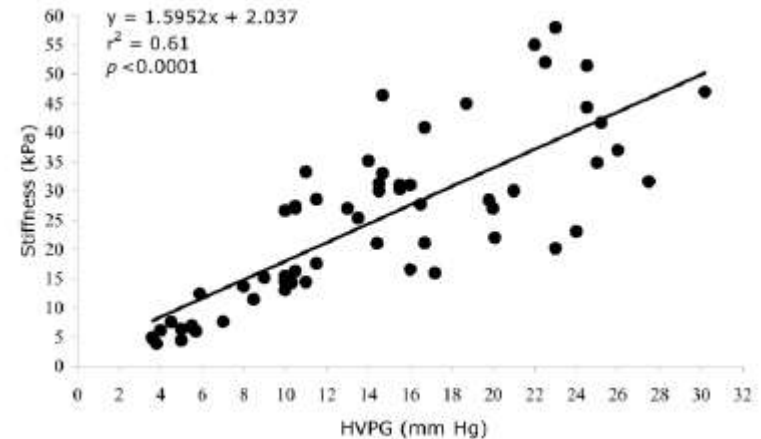


Castera L et al. J Hepatol 2008; 48: 835-847

Friedrich-Rust M et al. Gastroenterology 2008; 134: 960-974

Results of Fibroscan

- Correlation between elasticity and HVPG
- Prediction of esophageal varices and hepatocellular carcinoma?
- Treatment for HCV is associated with improvement of Fibroscan
- Fibroscan can differentiate slow and fast fibrosers after transplantation for HCV



Vizzutti F et al. Hepatology 2007; 45: 1290-1297
Vergniol J et al. J Viral Hepatitis 2009; 16: 132-140
Carrion JA et al. Hepatology 2010; 51: 23-34

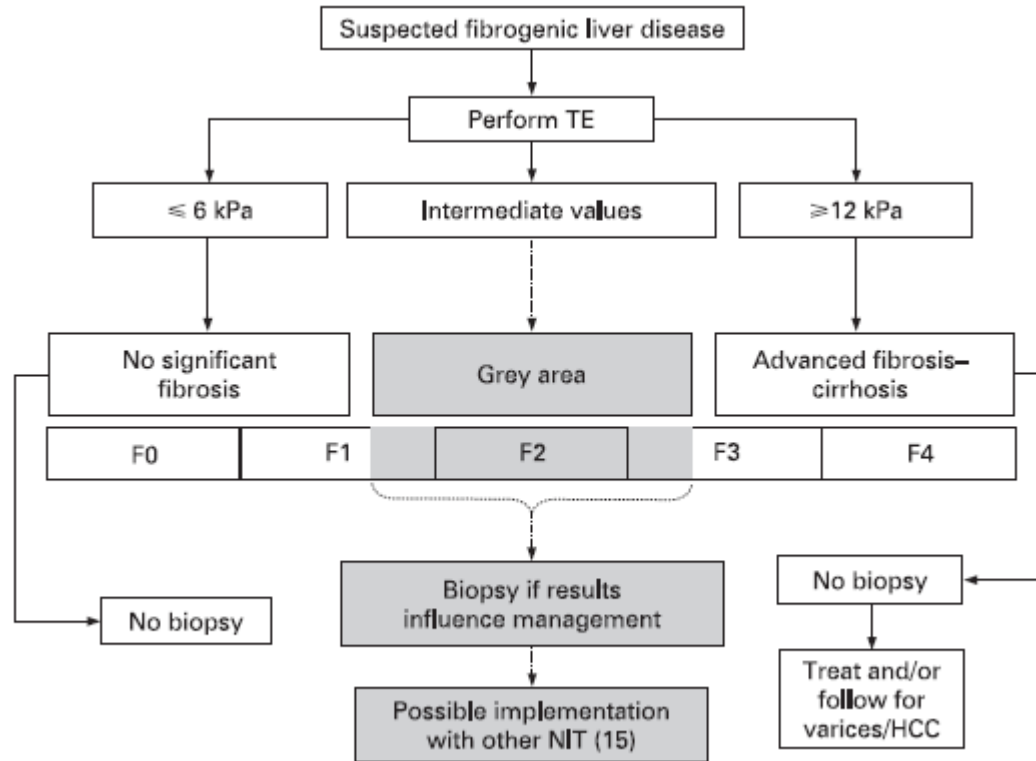
Limitations of Fibroscan

- Increase in elasticity
 - Necrosis and inflammation
 - Hepatic congestion
 - Bile duct obstruction
- Limited technical success: examinations are un-interpretable in 20%
 - Obesity
 - Ascites
 - Limited operator experience
- Moderate reproducibility
- Moderate accuracy

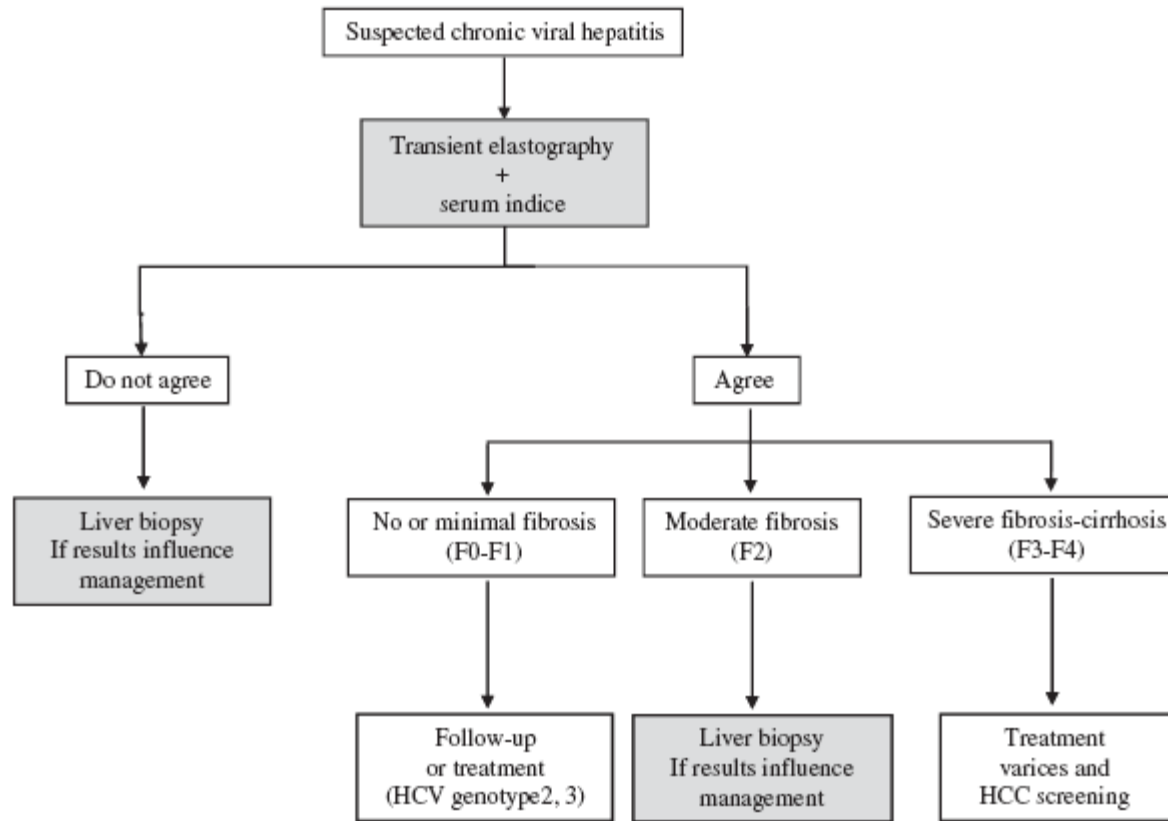
Arena U et al. Hepatology 2008; 47: 380-384

Castera L et al. Hepatology 2010; 51: online first

Diagnostic algorithm



Diagnostic algorithm



Acoustic radiation force imaging and supersonic shear imaging

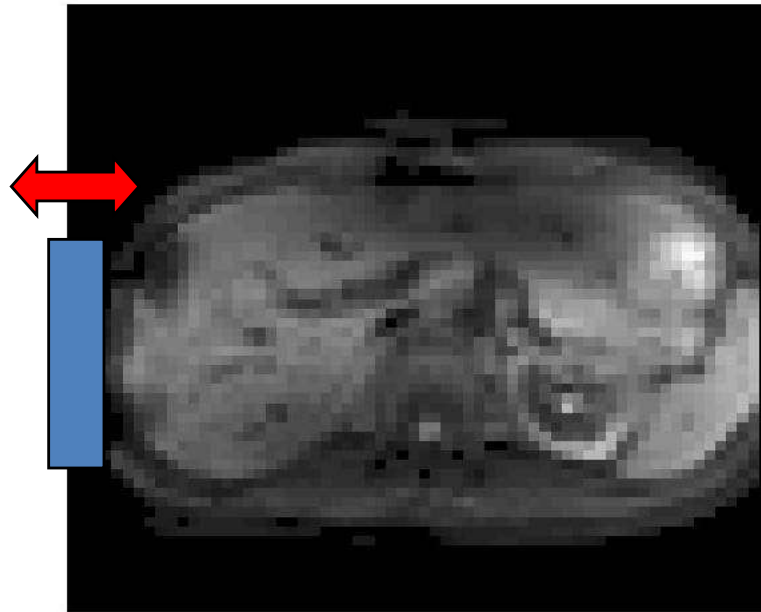
- Use of focused ultrasound beams for generating shear waves within organ
- Advantages relative to Fibroscan
 - Better penetration
 - Penetration through ascites
 - Ultrasound image
 - Combined with routine ultrasound examination
 - Assessment of focal liver lesions
- Preliminary results similar to Fibroscan

Muller M et al. Ultrasound Med Biol 2009; 35: 219-229

Friedrich-Rust M et al. Radiology 2009; 252: 595-604

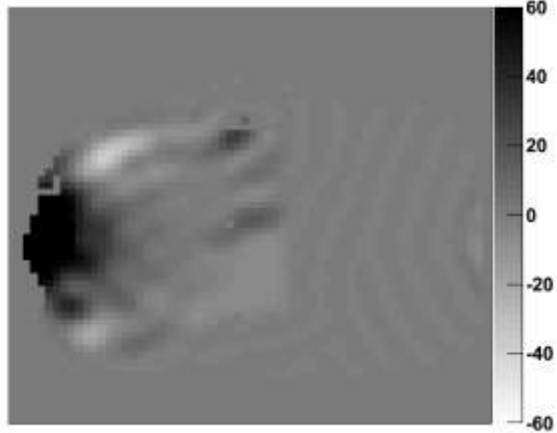
Lupsor M et al. J Gastrointest Liver Dis 2009; 18: 303-310

magnitude

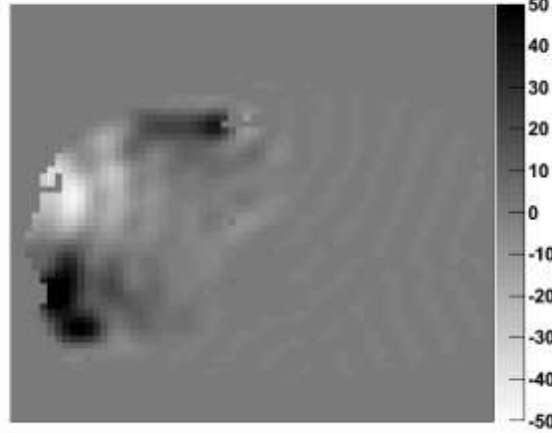


3D MR elastography

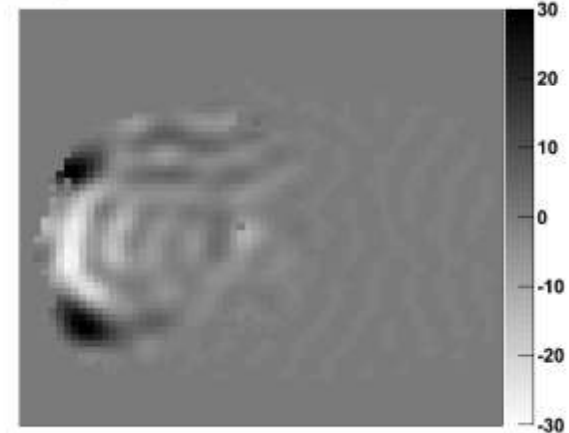
U_x [μm]

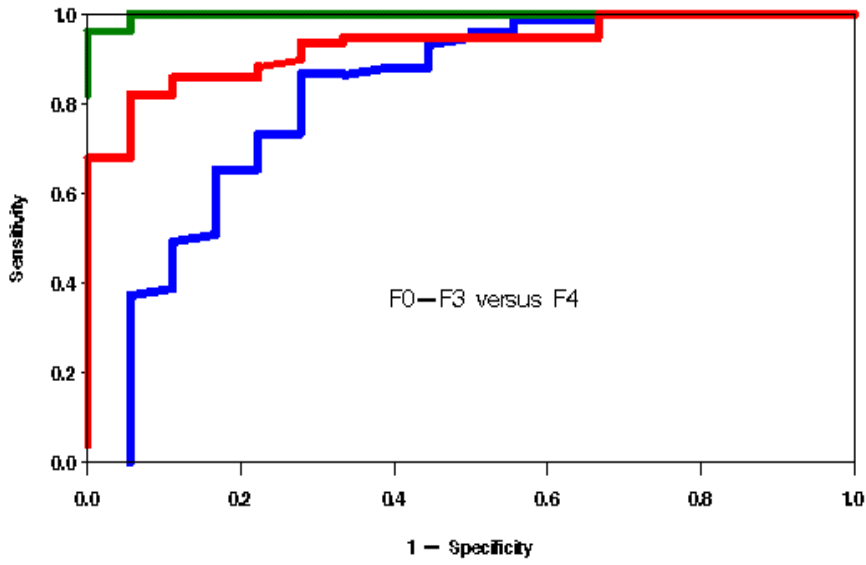
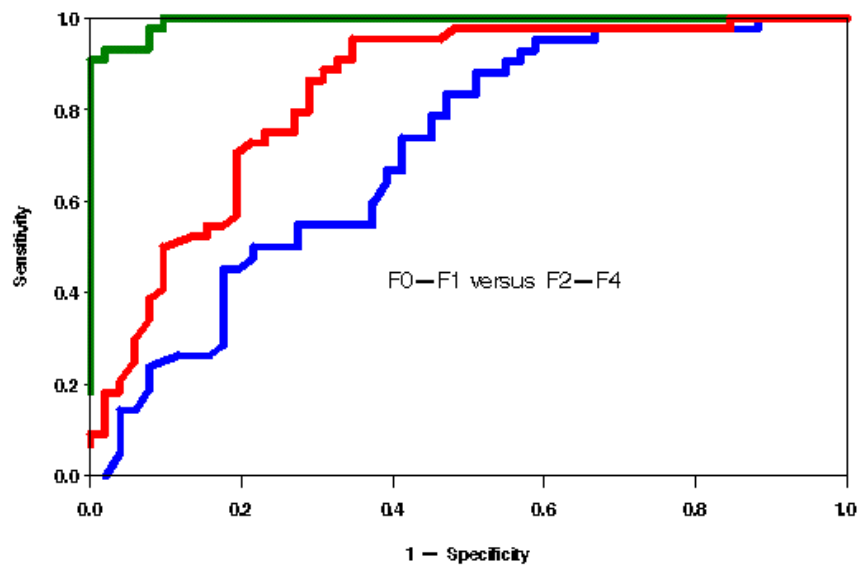
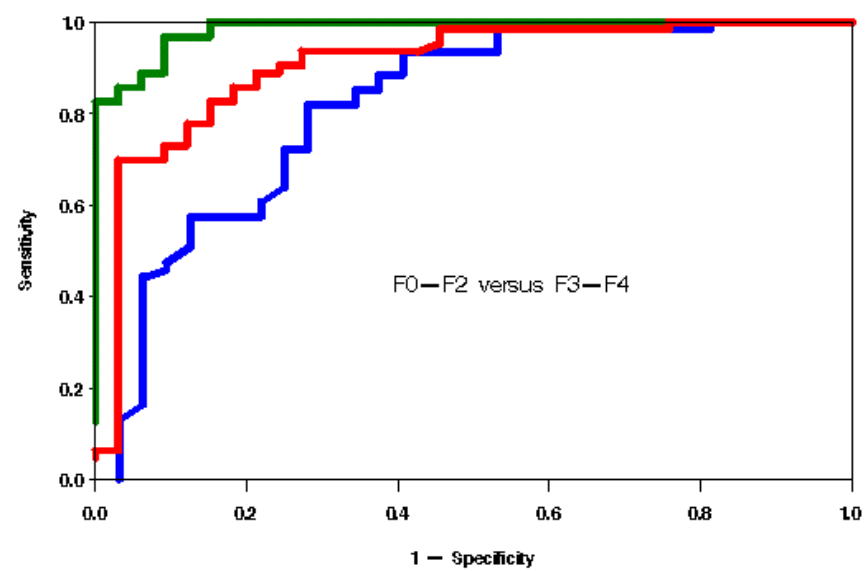
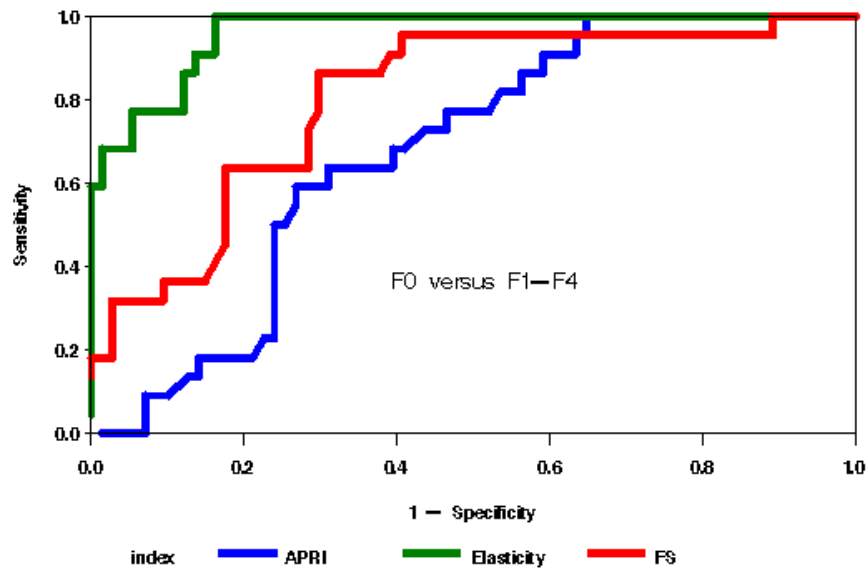


U_y [μm]



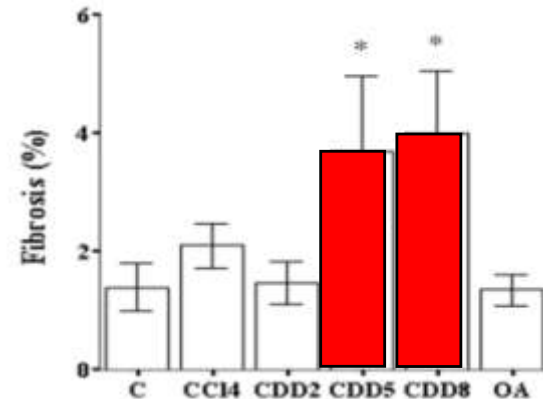
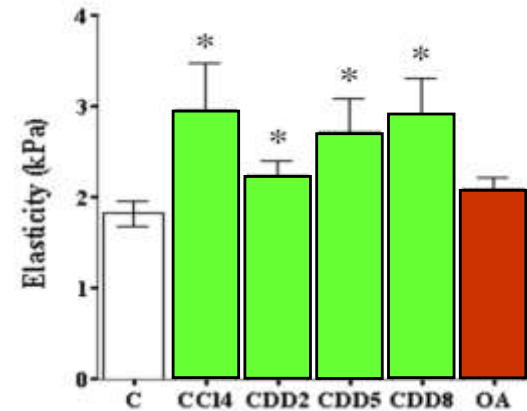
U_z [μm]





MR elastography

- MRE is sensitive to small changes of elasticity caused by activation of stellate cells
- Advantages relative to Fibroscan
 - Robustness
 - Obesity, ascites
 - Reproducibility
 - Accuracy
 - Combined with regular MRI examination
- Disadvantages
 - Availability
 - Cost



Conclusions

- Ultrasound elastography becomes the first-line examination in patients with suspected liver fibrosis
- Liver elasticity is influenced by other factors than fibrosis, including inflammation, stellate cell activation, congestion and bile duct obstruction
- MR elastography is a second line examination and has potential indications in
 - Discordant results especially at intermediate fibrosis stages
 - Staging of cirrhosis
 - Assessment of response to new anti-fibrotic treatments