Contribution of Phase-Contrast Magnetic Resonance Imaging in the study of hepatic fibrosis: preliminary results

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INTRODUCTION

Hepatic fibrosis is secondary to many etiologies (alcohol, viruses…) and the quantification of this fibrosis is a key point for the clinician. Hepatic puncture biopsy is the invasive gold standard for the assessment of degree of fibrosis. Many techniques, more or less reliable and a bit or not invasive, have been developed to evaluate it. Among those techniques, utrasonic transient elastography is widespread owing to the simplicity of the examination. During hepatic MRI exploration, morphological images are usually collected but we can also reach functional data using Phase contrast sequences (PC-MRI) . In this work, we wanted to appraise the potential links between elastometry data and parameters measured by PC–MRI.

METHODS

Patients: 17 subjects (52+/-17 years old) developing hepatic pathologies, in a fasting state for 6 hours, were enrolled into the study. Ultrasonic transient liver elastography Fibroscan® using a 3.5 Mhz transducer (Echosens, Paris, France) and MRI flow measurements in the portal vein (PV) were carried out. Ten Fibroscan measurements, using intercostal approach, were performed in nearly 3 min to assess the elasticity modulus (E) defined as the median value of the valid outputs.
MRI studies were performed with a 3T HDx MR Scanner (GE Healthcare, Milwaukee, WI) using a phased array body coil. 2D Fiesta sequences in apnea were used to localize the orientation of the section required for flow measurements. Gradient-echo Phase Contrast sequences were performed using respiratory and cardiac gating. Flow rates were calculated from 32 velocity images covering the cardiac cycle.
Acquisition parameters were: 4 View per segment, 1 Nex, Flip angle 25°, FOV 18x18 cm², Slice thickness 4 mm, Matrix size 256x128, TR/TE minimum, Band width +/- 31 kHz, Number of phases 32. Encoding velocity was set to 40 cm/s for PV. Acquisition time was nearly 2.5 min.
***MRI post-processing software*:** The software, developed in situ, uses a segmentation method based upon 2D active contours models, suitable for deformable vessels. This tool allows calculation of parameters such as flow rates or vessel section areas throughout the cardiac cycle.
***Statistical analysis*:** Pearson correlation test was used.

RESULTS AND DISCUSSION:

The elasticity modulus E varies from 4 kPa which corresponds to a healthy hepatic parenchyma, to more than 29 kPa which corresponds to a high grade of hepatic fibrosis. The evolutions of E as a function of the portal section variation ΔS ($\Delta S = S_{max} - S_{min}$) during the cardiac cycle and of the portal congestion index defined by $IC=S_{mean} / V_{mean}$, are depicted on figure 1: 3 distinct sub-groups, represented by symbols, clearly appear. For each sub-group, a strong and statistically significant linear correlation between the elasticity modulus and the parameters ΔS and IC is clearly highlighted. The clear segregation between the groups could correspond to the classification of fibrosis stage (F0, F1, F4). The lines y-co-ordinate value at the axis origin could then indicate the fibrosis threshold from one stage to another. For each sample, the lines E=f(ΔS) and E=f(IC) are increasing functions. Consequently, this means that an increase in E, corresponding to a hardening of the liver, would generate a more significant variation of the of the portal vein deformations and an increase in congestion index IC. During the evolution of fibrosis, the liver hardening results in an increase in the Young modulus and consequently an increase in the peripheral impedances, therefore generating an increase in portal pressure. This higher pressure will induce more significant deformations of the vessels' wall and this may explain the increasing shape of the curve E=f(ΔS). In the same way, the varaitions of the curve E=f(IC) is closely related to the increase in portal pressure induced by the fibrosis growth. Indeed, this rising pressure induces an increase in the average vessel area, which concomitantly associated with a decrease in mean velocity defined as the ratio of flowrate by the section area, then implies a significant increase in the congestion index.

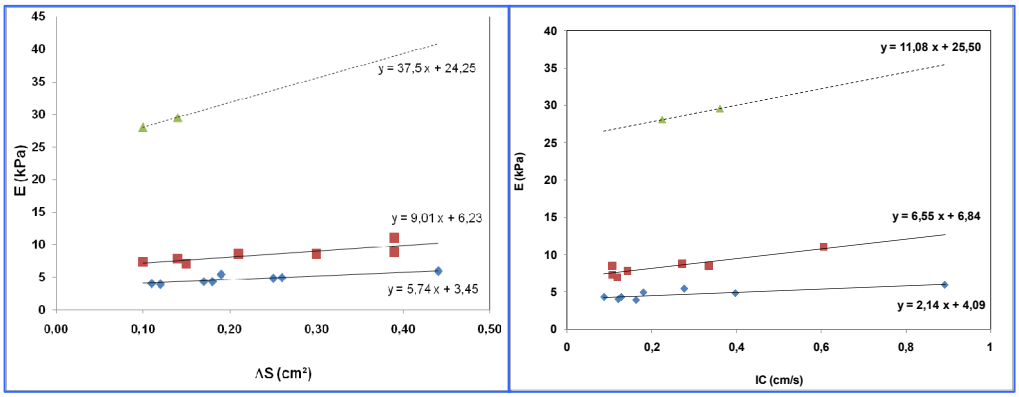

Figure 1 : Variations of elasticity E as function of ΔS and IC (filled lines represents the linear correlation curves de corrélation and dotted lines are drawn as an indication)

CONCLUSION:

Our feasibility study showed that flow parameters calculated from PC-MRI sequences are statistically stongly correlated with the elasticity measurements in the hepatic parenchyma using ultrasound technique.Specific studies of flows and vessel section areas in the portal vein could lead to a better understanding of hepatic physiopathology and open new ways of research toward the evaluation of treatments and the comprehension of evolution mechanisms involved in hepatic fibrosis.

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