Hepatic Vascular flow measurements by Phase Contrast MRI and Doppler echography: a comparative and reproductibility study

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INTRODUCTION

Many techniques permit the measurements of hepatic flows. Except Doppler echography and Phase Contrast MRI (PC-MRI), these examinations are invasive, so their use in clinical practice is limited. Doppler echography is widely used for liver blood flow measurements and remains the gold standard despite some defects. PC-MRI allows quantitative assessment of vascular velocity profiles without injection. At present time, this technique is used in clinical practice for cerebral flow measurements at Amiens' hospital but the imaging software had to be modified to match the requirements of the present study.

The main purpose of this work is to compare the two techniques in order to appraise their reproducibility at the hepatic level.

METHODS

Patients: 8 young healthy subjects (25 to 28 years old), in a fasting state for 6 hours, were enrolled into the study. Doppler echography using a transducer 5 to 2 Mhz (Philips HDI 5000, Eindhoven, Netherlands) and MRI blood flow measurements were carried out in the portal vein (PV) and proper hepatic artery (HA). 2 MRI and 2 Doppler examinations (1 year separation 2007/2008) were performed on the same subjects.

MRI studies were performed with a 3T imager (General Electric Medical Systems, 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 2D Fast Cine PC 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 256x256, TR/TE minimum, Band width +/- 31 kHz. Encoding velocities were set to 40 cm/s for PV and 70 cm/s for AH. Acquisition time was 2-3 min for each vessel.

***MRI post-processing software*:** The software (Fig.1), developed in situ, uses a segmentation method based upon 2D active contours models, suitable for deformable and moving vessels. This tool allows calculation of parameters such as flow rate, maximum velocity or vessel section area.

***Statistical analysis*:** Student t-Test and Pearson correlation test were used.

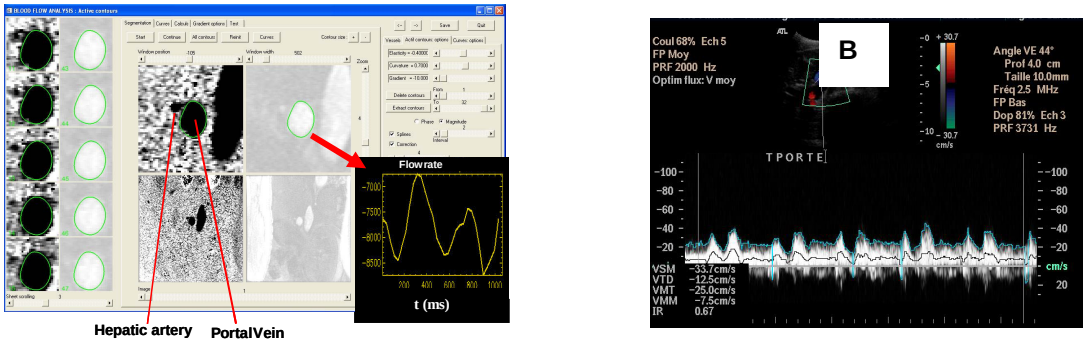

Figure1: *A-* Segmentation software view showing: *Final wall contours of a portal vein; temporal evolution curve during a cardiac cycle, the proper hepatic artery near the portal vein. B- Doppler flow waveform*

RESULTS AND DISCUSSION:

	Portal Vein ***Doppler***		Proper hepatic artery ***Doppler***		Portal Vein ***PC-MRI***		Proper hepatic artery ***PC-MRI***	
	2007	2008	2007	2008	2007	2008	2007	2008
V_{max} (cm/s)	46,6 ± 22,6	51,4 ± 16,7	132 ± 59	136 ± 53	32,1 ± 6,9	29 ± 10,1	56,9 ± 14,8	68,5 ± 33,5
Area(cm²)	1,07 ± 0,44	1,13 ± 0,24	0,19 ± 0,08	0,19 ± 0,09	1,44 ± 0,32	1,56 ± 0,34	0,25 ± 0,11	0,23 ± 0,06
Flow (ml/min)	1540 ± 753	1696 ± 479	461 ± 483	720 ± 385	949 ± 195	1023 ± 237	232 ± 74	285 ± 125

Table1 *Flow rates, velocity values and vessels' section areas measured in PV and AH*

The total hepatic flow rate (Table1) determined by MRI flowmetry (nearly 1.3 L/min) in healthy subjects is closed to literature data. Conversely, this value is overestimated (> 2 L/min) by Doppler technique.

As expected, the more reproducible parameter with Doppler echography is the maximum velocity. Owing to area measurements errors, it was not the case for flow values.

The standard deviations calculated from Doppler measurements were higher than those observed with MRI. No significant correlation could be highlighted between Doppler echography and PC-MRI measurements.

For both Doppler and MRI, no significant differences could be exhibited from one year to another for all the parameters. Nevertheless, contrary to Doppler technique a good correlation was shown for portal vein area and flow measurement using PC-MRI.

At the hepatic artery level, the measurements' deviations are far more important than those recorded at the portal vein level for the two flowmetry methods. This is related to the difficult delineation of the proper hepatic artery which size is small.

CONCLUSION: Though the size of the studied population was limited, the flow measurements' variability of MRI flowmetry is lesser with a correlation superior to Doppler data.

Our feasibility study shows that MRI hepatic flowmetry could be a useful tool in clinical practice with a short examination duration. However, improvements are necessary in order to accurately detect the proper hepatic artery. Many clinical applications such as liver cirrhosis severity or blood flow changes during tumoral pathologies, can be considered but require further validation.

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