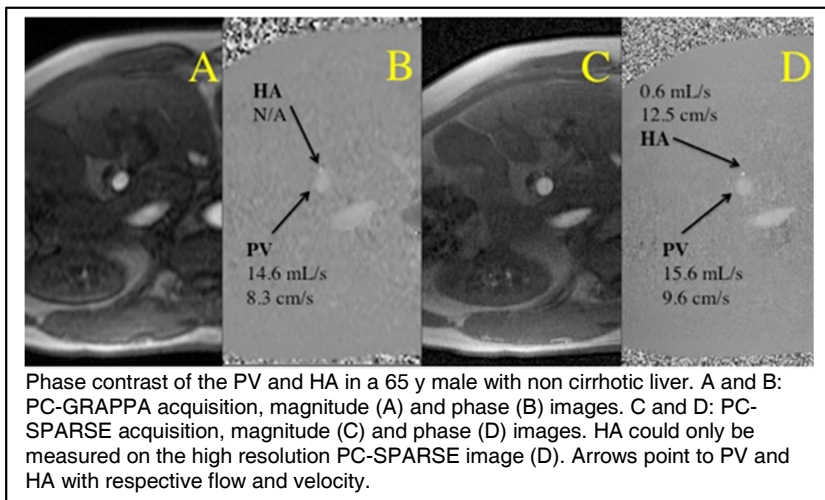


## Hemodynamic changes in healthy and cirrhotic liver measured using a breath-hold high resolution, highly accelerated k-t SPARSE-SENSE phase contrast sequence.

Hadrien A. Dyvorne<sup>1</sup>, Ashley Knight-Greenfield<sup>1</sup>, Nancy Cooper<sup>1</sup>, Cecilia Besa<sup>1</sup>, Ricardo Otazo<sup>2</sup>, Daniel K. Sodickson<sup>2</sup>, and Bachir Taouli<sup>1</sup>  
<sup>1</sup>Mount Sinai School of Medicine, New York, NY, United States, <sup>2</sup>New York University Langone Medical Center, New York, NY, United States

**Target audience:** radiologists and physicists with interest in abdominal MRI and flow imaging.

**Purpose:** In liver cirrhosis, major hemodynamic changes in the liver dual blood supply are observed (1,2). Increased organ resistance to blood flow may result in portal hypertension with complications such as variceal bleeding, as well as in an increase in hepatic blood supply from the hepatic artery (HA). Phase contrast (PC) cine MRI is a robust flow measurement technique that, when accelerated using a joint compressed sensing and parallel imaging approach such as k-t SPARSE-SENSE, can provide high spatial resolution images in a single breath-hold (3). This study evaluates the use of a highly accelerated k-t SPARSE-SENSE PC technique in comparison with standard parallel imaging PC to detect changes in hepatic dual blood flow in cirrhotic liver.



**Methods:** 77 patients (M/F 49/28, mean age 54 y, including 36 with non cirrhotic liver, and 41 with cirrhosis and portal hypertension) were enrolled in this IRB approved retrospective study. All subjects underwent MRI exams at 1.5T (Siemens Avanto), including an accelerated cine PC sequence using parallel imaging (GRAPPA R=2, 1.8x1.8 mm in-plane resolution, labeled PC-GRAPPA), and a highly accelerated cine PC sequence using k-t SPARSE-SENSE reconstruction (R=6, 0.9x0.9 mm in plane resolution, labeled PC-SPARSE) (3). Each acquisition was performed within a single breath-hold by selecting a plane perpendicular to the main portal vein (PV) with through plane velocity encoding ( $V_{ENC}=50$  cm/s), using peripheral pulse as retrospective cardiac trigger. ROIs were drawn in the portal vein (PV) and HA (when identified), to extract total flow and mean velocity averaged over the cardiac cycle. A Mann-Whitney test was performed to assess differences in flow

parameters (PV and HA mean velocity and flow, arterial fraction  $ART=HA$  Flow/total hepatic flow) between patients with and without cirrhosis.

**Results:** PV flow was measured in all 77 subjects using both sequences, and HA flow was successfully measured in 56 subjects using PC-GRAPPA and 65 subjects using PC-SPARSE (Fig. and Table). Both sequences yielded similar velocity and flow values in PV and HA ( $p > 0.08$ ). Mean PV velocity was significantly lower in cirrhotic subjects (Table) for both sequences ( $p < 0.001$ ). ART was significantly higher in cirrhotic subjects using PC-SPARSE only ( $p=0.022$ ). There was no significant difference in PV or HA flow between normal and cirrhotic subjects, except for PV flow measured using PC-GRAPPA ( $p=0.007$ ).

Flow parameters	PC-GRAPPA			PC-SPARSE		
	Non cirrhotic	Cirrhosis	p	Non cirrhotic	Cirrhosis	p
<b>PV Flow</b>	23.1 ± 6.9	18.8 ± 9.3	<b>0.007</b>	20.1 ± 7.2	17.1 ± 7.5	0.1
<b>PV mean Velocity</b>	11.9 ± 2.9	9.1 ± 2.7	<b>&lt;0.001</b>	12.0 ± 3.0	9.1 ± 2.7	<b>&lt;0.001</b>
<b>HA Flow</b>	4.8 ± 6.0	4.9 ± 3.7	0.27	2.2 ± 2.9	2.4 ± 1.7	0.11
<b>HA mean Velocity</b>	11.1 ± 7.7	12.4 ± 6.6	0.20	10.3 ± 6.6	11.8 ± 6.1	0.26
<b>ART</b>	14.9 ± 11.5	23.4 ± 18.6	0.072	8.9 ± 8.0	14.5 ± 14.6	<b>0.022</b>

Flow parameters in patients with and without cirrhosis using PC-GRAPPA and PC-SPARSE sequences  
 Flow in mL/s, Velocity in cm/s, ART: arterial fraction (%)

**Discussion:** With a high resolution k-t SPARSE-SENSE PC sequence acquired in a single breath-hold, it is possible to detect changes in hepatic arterial and portal venous flow that occur in cirrhosis. The larger value of ART observed in the PC-GRAPPA sequence is possibly due to partial volume

effects, producing falsely elevated values in HA flow. Previous studies have demonstrated variable results in terms of PV flow, but lacked assessment of the liver dual blood supply. By examining the PV and HA simultaneously using ART, we may be able to more accurately characterize blood flow in cirrhosis. This technique has potential for the diagnosis of portal hypertension and monitoring before and after TIPS placement.

### References

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**Conclusion:** The application of highly accelerated k-t SPARSE-SENSE cine phase contrast with high spatial resolution allows improved detection of hepatic artery and discrimination of cirrhotic from non-cirrhotic patients using the arterial fraction of total hepatic flow.