Unenhanced MR Liver Circulation Imaging using a Triple Inversion Recovery ASL Technique

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INTRODUCTION: Selective visualization of the liver circulation without the need of a contrast agent would have great potential for the evaluation of patients with renal dysfunction and liver diseases. The evaluation of the hepatic circulation is very challenging because of its arterial and venous blood supply: the arterial source is the hepatic artery and the venous source is the portal vein, while the main output system is the main hepatic vein. The selective visualization of those vessels may have a great impact on the clinical evaluation of most chronic liver diseases and in hepatic transplant patients [1]. In this work we sought to study the utility of a recently developed new Arterial Spin Labeling technique for the visualization of the liver circulation. **METHODS:** Our group has recently developed a new ASL technique that does not require a subtraction step and is based on a triple inversion recovery pre-pulse (TIR-ASL) [2]. Briefly this technique uses a Triple Inversion Recovery pre-pules and exploits the ability of the two non-selective Inversion-Recovery prepulses to null background signal while maintaining the signal of labeled blood using a regional inversion pulse (Figure 1). With the optimal selection of the inversion times TI1 and TI2, it is possible to obtain arterial angiograms of the labeled vessels. In order to use this technique for the evaluation of the venous system we developed a variation of this technique and we optimized the parameters TI1 and TI2 in order to fit the sequence into 2 heartbeats (Fig 2). The scan planning to obtain the TIR-ASL angiogram of the three main liver vessels is shown in Fig. 3: Volume A labels blood in the heart in order to obtain the hepatic artery angiogram; volume B labels the abdominal main venous system below the liver in order to obtain the portal vein venogram; volume C labels the inferior half of the liver in order to obtain the main hepatic vein venogram. The TIR-ASL pre-pulse was implemented on a 1.5T Achieva Gyroscan MR scanner (Philips Healthcare, Best, NL) and was tested in 5 healthy subjects. TIR-ASL can be combined with any imaging readout. In this work we combined it with an ECG triggered 3D segmented k-space gradient echo readout. **RESULTS:** We identified a set of inversion delays (TI1 and TI2) that provided an optimum solution to null the static tissue for the 2 heartbeats acquisition. The parameters used were: heart frequency: 60 bpm, RR: 1000 ms, TI1/TI2 = 798/244 ms; and heart frequency: 70 bpm, RR: 860 ms, TI1/TI2 = 738/232 ms. The whole abdominal aorta and its main branches, including the common and proper hepatic artery, were successfully visualized in all subjects. The portal vein including its main branches was clearly visualized in all subjects due to complete suppression of the liver signal. The hepatic vein was also clearly visualized in all the subjects (Fig. 4). **CONCLUSIONS:** We successfully demonstrate a new ASL approach for a selective visualization of the main liver circulation. This technique has the advantages of not requiring contrast agent injection or a subtraction step like most classic ASL techniques. Studies in patients with liver disease are now warranted to investigate its clinical usefulness. **REFERENCES:**

[1] Shimada K JMRI 2009 [2] Andia ME MRM 2011.

Figure 1- TIR-ASL sequence. NsIR: Adiabatic Non-Selective Inversion Pulse. sIR: Selective Inversion Pulse, NR: Navigator Restore Pulse. N: Navigator, AQ: Acquisition.

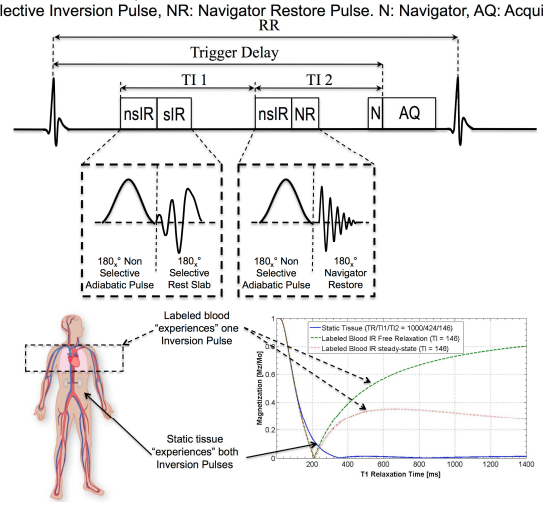

Figure 2- TIR-ASL sequence using two-hearbeats. NsIR: Adiabatic Non-Selective Inversion Pulse. sIR: Selective Inversion Pulse, NR: Navigator Restore Pulse. N: Navigator, AQ: Acquisition.

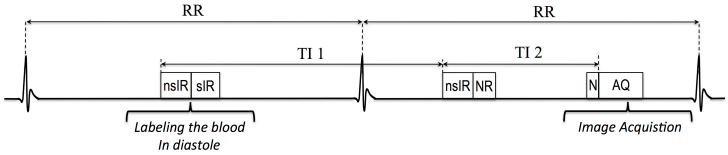

Figure 3- Scan Planning showing the position of the selective Inversion Pulse. A: to obtain the hepatic Artery angiogram; B: to obtain the portal vein venogram, and C: to obtain the hepatic vein venogram.

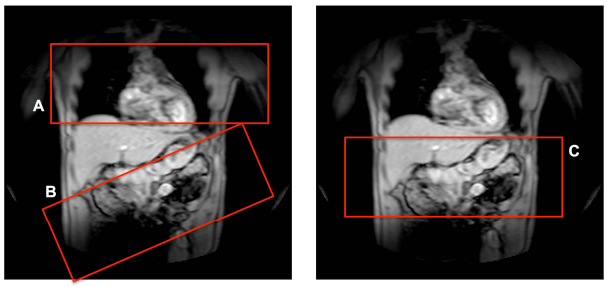

Figure 4- Maximum Intensity Projections (MIPs) of the Hepatic Artery (A), Portal Vein (B), and Hepatic Vein (C).