INITIAL STUDIES OF PORTAL VEIN FLOW USING THE SELECTIVE SATURATION RECOVERY SPIN ECHO (SSRSE) METHOD IN COMBINATION WITH CARDIAC GATING

P. Schmalbrock, W. Hunter, A. Masaryk, F. Cornhill, S. Stiving, E. Herderick. The Ohio State University, Columbus, Ohio. F. Wehrli, A. Shimakawa, The General Electric Company, Milwaukee, Wisconsin

Knowledge of flow in the portal vein could significantly contribute to the assessment of patients with hepatic disease. Yet, this "hidden" vascular compartment remains inaccessible to all but the most invasive techniques of modern medicine. Although the venous flow is less pulsatile than arterial flow, significant velocity variation occurs during the cardiac cycle. Despite the trend of many investigators to assume steady state flow in the venous system cardiac gating would seem to be indicated for portal vein flow measurements. While standard multi-spin-echo pulse sequences provide qualitative information about the flow, the selective saturation recovery spin-echo method (SSRSE) enables quantification of velocity.[1,2] This method, which utilizes time of flight washout effects, consists of two selective 90° pulses followed by a selective 180° rephasing pulse. Protons flowing through the imaging slice are initially excited by the first 90° pulse. During the interpulse time (TI) between the 90° pulses these tagged protons are partially replaced by unexcited protons depending on velocity (v) and slice thickness (d). Since, in whole body imaging systems, spin-echoes rather than free induction decays are acquired, the two 90° pulses are followed at TE/2 by the selective 180° pulse. The resultant signal intensity (I) is a composite of the magnetization of tagged and untagged protons. For plug flow perpendicular to the imaging plane the relative intensity can be calculated from:

$$I = \begin{cases} [(V/d)TI + (1 - (V/d)TI\ (1 - \exp(-TI/T1)]\ (1 - (V/d)/(TE/2))\ \exp(-TE/T2) & \text{for } 0 \leq V \leq d/TI \\ [1 - (V/d)\ (TE/2)]\exp(TE/T2) & \text{for } d/TI \leq V \leq d/(TE/2) \end{cases}$$

Therefore, the velocity can be calculated from images perpendicular to the flow direction obtained at different interpulse times.

Sagittal images were acquired with a 500 msec delay following the QRS trigger signal. These images of 1cm slice thickness were obtained with five different TI. Figure 1 shows the relative pixel intensities at the center of the portal vein as a function of the interpulse time. From this curve a preliminary value for TI = 78 ± 25 msec at the turn over point can be obtained. This results in a velocity V = 13 ± 4 cm/sec at the center of the portal vein.

A more detailed analysis of the data including the calculation of velocity profile curves is in progress.

1.) F. W. Wehrli, J.R. MacFall, L. Axel, D. Shutts, G.H. Glover, R.J. Hertkins. Noninvasive Medical Imaging (1984) 127.
2.) F.W. Wehrli, A. Shimakawa, J.R. MacFall, L. Axel, W. Perman. Journal of Computer Assisted Tomography 9 (1985) 537.

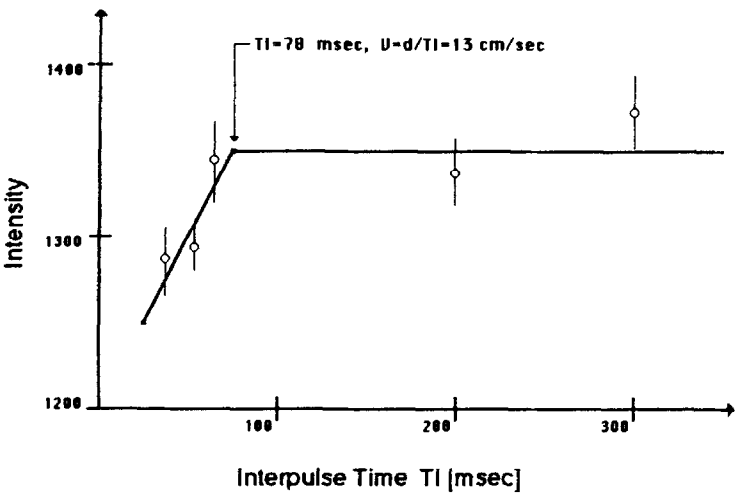

Figure 1: Relative Intensity for the center pixel in the portal vein as a function of the SSRSE interpulse time