Simultaneous Angiography and Venography Techniques Compared at 7T

S. Barnes[1,2], Y. Ge[3], L. Tang[3], Z. Zhang[3], D. K. Sodickson[3], R. I. Grossman[3], and E. M. Haacke[2]

[1]Radiology, Loma Linda University, Loma Linda, California, United States, [2]Wayne State University, Detroit, Michigan, United States, [3]New York University School of Medicine

Introduction: Two techniques have been presented in the last year to acquire both angiographic and venographic information in a single acquisition (MRAV) using susceptibility weighted imaging (SWI). One uses a double echo approach with the shorter echo used for the angiography and the longer echo used for the venography (1). The other uses a single echo that is a compromise between the two with a contrast agent used to improve image quality (2). In this work we sought to apply and compare both of these techniques at 7T with the exception of not using a contrast agent with the single echo sequence. 7T should offer advantages for the single echo technique as the optimal echo time for the venography shortens with field strength bringing it closer to the short echo time needed for a good angiography possibly alleviating the need for a contrast agent.

Materials and methods: All SWI images were acquired at 7T with a resolution of 0.5x0.5x1mm^3. Imaging parameters were TR=42 and 31ms, TE=5.6/22 and 15.7ms, FA=30°, and BW=485/40 and 70 Hz/pixel for the double echo and single echo sequences respectively. Maximum intensity projections (MIPs) to visualize the arteries were performed on the original magnitude data. SWI processing with the high pass filtered phase image was performed, and minimum intensity projections (mIPs) generated to visualize the veins. MIP, mIP, and single images from the double and single echo techniques were compared to evaluate venous and arterial contrast.

Results: The double echo technique was able to provide a high quality MRA and MRV due to the optimal echo time used for each respective image. The long echo for the MRV was slightly longer then optimal causing some additional air-tissue interface artifacts and additional blooming of the veins but overall the quality of the venography is very high. The single echo technique shows some flow related losses in the larger arteries (MCA) due to the longer required echo. At 7T an echo of 10-15ms is needed to obtain decent venous contrast which still causes some flow loss. Some of the peripherial arteries also showed signal loss down the center of the artery.

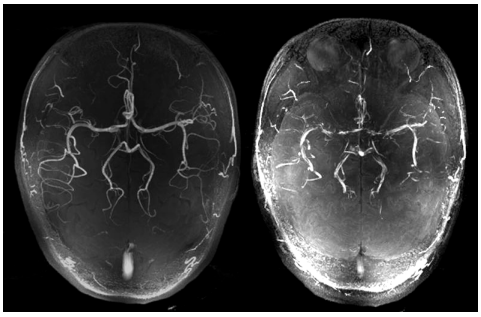

Figure 1. MIP over 41mm for double echo (left) and single echo (right) with TE=5.6 and 15.7 ms respectively. The longer echo time for the single echo causes some flow loss especially in the MCA.

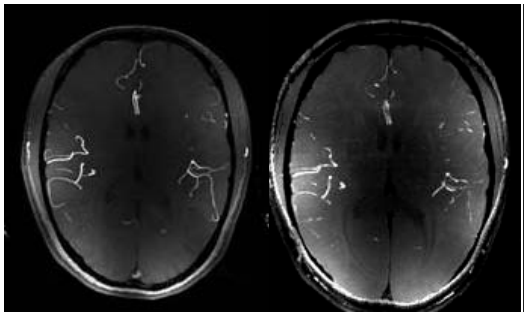

Figure 2. MIP over 5mm for double echo (left) and single echo (right) sequences. Small vessels for both scans are similarly depicted although the background in the single echo scan is slightly more heterogeneous reducing contrast somewhat.

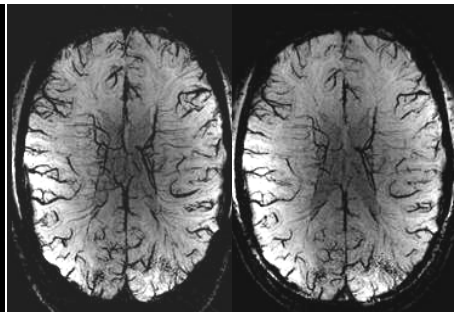

Figure 3. mIP over 5mm of susceptibility weighted images four double echo (left) and single echo (right) with TE=22 and 15.7 ms respectively. Venography from both sequences is excellent with the small veins being well depicted.

Discussion and Conclusion: The double echo sequence produces an angiography and venography that compares well with a standard time of flight (ToF) angiography and SWI venography. However, concerns still remain about the effects of non-compensated flow effects in the phase encode directions for the second echo. The second echo is only flow compensated in the read direction which could cause the arteries to have a phase effect and lead to arterial contamination of the venography. The long echo time required for the second echo (22ms) also causes some additional susceptibility artifacts but still produces a very good venography. The venography and angiography of the small arteries in the single echo sequence is comparable to the double echo technique. However, it still cannot match the quality of the double echo angiography in the larger arteries due to flow dephasing. Despite the need for very high bandwidth in the first echo to achieve an appropriate TE in the second echo and concerns about flow compensation, the double echo sequence produces a superior angiography and a comparable venography. The single echo sequence is viable at 7T without a contrast agent and offers a significant time savings compared to the double echo sequence (7:30 vs. 10:06 without parallel imaging).

1. Du YP, Jin Z. Simultaneous acquisition of MR angiography and venography (MRAV). Magn Reson Med 2008;59(5):954-8.
2. Barnes S, Manova E, Haacke EM. Angiography and Venography in a Single SWI Acquisition. Proc of 16th annual meeting of ISMRM, 2008, Toronto, #2231.