Challenges with Coil Calibrations in In-Vivo Phase Contrast SENSE

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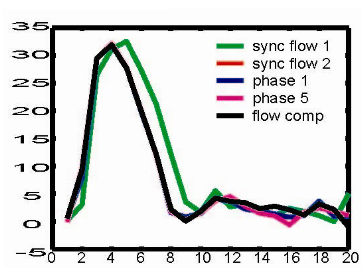
Introduction: Phase contrast imaging, or PC, is a useful tool for clinicians to diagnose diseases such as myocardial shunts. PC employs a flow-encoding technique that encodes the velocity of the blood flow onto the phase of the MRI image. PC unfortunately requires considerably longer duration to scan due to the extra acquisition. Parallel imaging methods such as SENSE (1) offer a way to reduce the scan time. Breathheld scans are more manageable for patients. SENSE requires accurate coil sensitivity maps to obtain a feasible image reconstruction. This abstract examines different choices for selecting coil sensitivity maps for phase-contrast SENSE.

Methods: A phase-contrast scan with 20 cardiac phases was performed with a reduction factor of 2 on a 4-coil torso coil on GE Signa 1.5T scanner. A VENC of 150cm/sec was used. The scan was acquired with 6 views per segment. A separate torso-coil calibration and a body-coil calibration were performed. These calibrations were done with flow encoding as well. 5 calibration cases were performed for each calibration type. Case 1 synchronizes each flow image of the calibration scan with that of the SENSE acquired scan. Case 2 synchronizes the first flow image of each cardiac phase as calibration for the corresponding pair of flow images for the SENSE scan. Case 3 uses the first flow image of the first cardiac phase as the calibration for the entire set of cardiac phases. Case 4 uses the first flow image of the fifth cardiac phase as the calibration for the entire set. Case 5 uses a standard cine GRE sequence with flow compensation as the calibration scan and synchronizes the cardiac phases together. Finally, another phase contrast scan was performed with a 3d calibration scan. Sum-of-squares was used as the calibration method for the SENSE reconstruction. The 3d sequence was a spoiled GRE sequence with 5 deg flip angle, 128x128x32 imaging matrix, nongated, and non-flow-encoded. All flow measurements were calculated using the complex phase-difference.

Results: Fig. 1 shows the flow measurements for all the cases performed with the body coil calibration. Fig 2 shows the flow measurements for the sum-of-squares calibration. Fig 3 shows an image of the magnitude and phase difference reconstruction. Fig. 4 shows the flow measurements with and without SENSE for the 3d calibration.

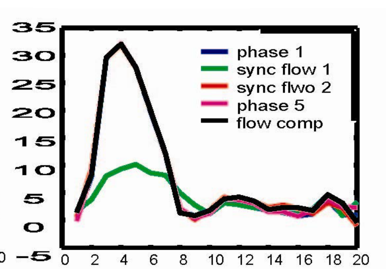
Discussion: The flow measurements acquired through SENSE almost all agreed well. The case 1 calibration gave an incorrect flow measurement because each flow-encoded calibration image cancels out the flow-encoded phase of the SENSE acquired scan. For the body coil, this is not as significant because the flow-encoded phase of the body scan has canceled out most of the torso coil calibration flow-encoded phase. Although the flow measurements for case 3 and case 4 agree with the others, there may be misregistration between coil calibration and SENSE acquisition scans due to cardiac motion and flow in future scans. The flow-compensation calibrations also agreed with the other cases. Self-calibration scans would be important for future research. The 3D scan shows reasonable agreement between the non-SENSE and SENSE acquired scan. The lack of gating has not apparently caused a difference in this particular scan. There is residual chest wall aliasing in the reconstruction due to misregistration between the calibration scan and SENSE acquisition scan. Future work would include situations when the chest wall has aliased onto the aorta. This would demand more robust SENSE calibration measurements.

Flow (mL/min) Figure 1



Cardiac phase

Flow (mL/min) Figure 2



Cardiac phase

Case 1: sync flow 1
Case 2: sync flow 2
Case 3: phase 1
Case 4: phase 5
Case 5: flow comp

Figure 3

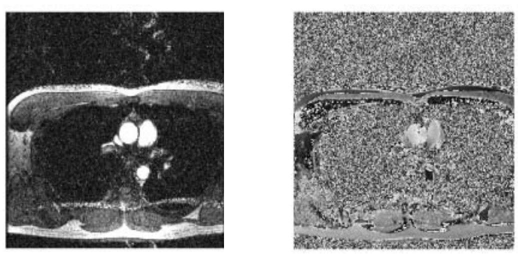
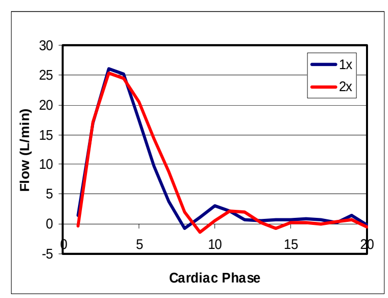


Figure 4



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