Comparison of under-sampled Cartesian pulmonary perfusion MRI reconstructed with either view sharing or HYCR

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INTRODUCTION: Pulmonary perfusion MRI is emerging as a useful clinical tool in assessing lung function in a wide range of diseases, including pulmonary embolism1, pulmonary hypertension2, and cystic fibrosis3. However, truly quantitative pulmonary perfusion MRI has been limited by the need for both high temporal-spatial resolution and full-lung coverage. The purpose of this work was to compare the performance of 3 different Cartesian under-sampling methods in combination with 2 alternative reconstruction methods for both qualitative pulmonary perfusion imaging and quantitative assessment of contrast dynamics.

METHODS: Twenty-two (22) healthy subjects (10M, 13F, age 22-61yrs) were scanned in this IRB-approved study on a 1.5T scanner (MR450w, GE Healthcare, Waukesha, WI) using an 8-channel cardiac coil. Pulmonary perfusion MRI was performed using a 3D spoiled gradient echo pulse sequence with each of 3 k-space sampling schemes (top row, Fig. 1): 1) similar to the Cartesian Acquisition with Projection Reconstruction-like (CAPR) method, 2) Differential Subsampling with Cartesian Ordering (DISCO), and 3) Interleaved Variable Density (IVD). Gadobenate dimeglumine (0.05 mmol/kg) was injected at 4 mL/s followed by 35 mL saline administered at the same rate. Scans were performed in a randomized order at least 20 min apart. Scan parameters included: 22s breath-hold, whole-lung 4mm isotropic resolution, FOV=40(SI) × 28(AP) × 40(LR) cm², TE/TR=0.6/1.7ms, FA=12°, BW=±125kHz, parallel acceleration 2×2, 1.0s reconstructed temporal resolution for the first 8 subjects and 0.5s for the remaining 14 subjects. Data from each acquisition were reconstructed using two methods: view-sharing (VS) and HYCR reconstructions.

RESULTS: All reconstructions generated good quality peak lung enhancement images. There were no significant differences in image quality between the acquisition-reconstruction methods (bottom rows, Fig. 1). The only factor that demonstrated a statistically significant effect on image quality was the injection order (p=0.04, 0.12, 0.01 for the 3 readers). The principal factors affecting the quantitative measures were injection order (higher maximum and slope on earlier injections, p<0.001) and reconstruction method. Pair-wise comparison of VS and HYCR reconstructions from the same data showed 23% higher maxima, 5% steeper maximum slopes, and 6% shorter rise times with HYCR than with VS reconstructions, with total population mean ± SD values shown in Table 1. These differences were greater at 0.5s temporal resolution than at 1s, although only rise time showed a statistically significant difference with temporal resolution (p=0.036). The rise time observed with Scheme 3 sampling was shorter than with Scheme 1 (p=0.003), although there was no significant difference between the acquisition methods using the other metrics.

CONCLUSION: All 6 acquisition-reconstruction methods evaluated in this study produced images of similar quality. The shorter rise times, greater maximum intensities, and steeper slopes of contrast enhancement curves based on HYCR suggest a higher true temporal resolution and may yield higher accuracy than view-sharing for whole-lung quantitative perfusion MRI.