INTRODUCTION
4D MR flow imaging is powerful tool for comprehensive hemodynamic assessment but is hampered by long scan times [1]. Compressed sensing (CS) has been suggested as a means to accelerate scan time by exploiting image sparsity in spatial domain, temporal domain, and coil sensitivity maps [2,3]. This study explores the compressed sensing technique with radial trajectory like undersampling patterns in the ky-kz plane (on Cartesian coordinates). Our preliminary results of aortic phase-contrast imaging showed that the sampling pattern is robust to undersampling artifacts. Compressed sensing image reconstruction with an undersampling factor of 3 has been shown to provide good image quality and accurate flow measurements.

MATERIALS AND METHODS
A prospectively gated Cartesian 3D CINE phase-contrast sequence with interleaved three-directional velocity encoding was used to acquire phase reference and velocity-encoded data sets on a 1.5T Siemens Avanto scanner with a 4-channel coil. Scanning parameters were: venc = 200 cm/s, FOV = 320x240x55 mm³, image matrix = 128x96x22, TR/TE = 4.4/2.9 ms, FA=8°, 19 reconstructed time frames of 35 ms temporal resolution, and ~25 mins scan time with respiratory NAV gating window of 7 mm.

The fully sampled data was reconstructed as the reference image. Different undersampling patterns designed for GRAPPA (Fig. 1a) and CS (Fig. 1b-c) reconstructions were applied on the full data set. In Fig. 1a, along the phase encoding direction (horizontal), data of every other line was taken away at the high frequencies, resulting an undersampling factor of R=1.6. Fig 1 b-c have data on radial lines whose coordinates were rounded onto Cartesian grid, with R=2 and R=3 respectively. Image reconstruction with Zero filling (ZF) was also applied on the undersampled data. ROI in the aorta was selected through all the time frames and the mean velocity within the ROI was measured.

RESULTS AND DISCUSSION
In this study, different undersampling patterns were used to accelerate phase-contrast imaging. Our preliminary results have shown that radial like pattern on Cartesian grid is less sensitive to undersampling artifacts if compared to GRAPPA undersampling. Image reconstruction with compressed sensing provides good image quality and accurate flow measurements at an acceleration factor of 3, which will reduce the 4D flow scan time to be less than 10 minutes.

REFERENCES