**Direct Virtual Coil (DVC) Coil Combination for Non-Cartesian 4D Flow Imaging**

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**INTRODUCTION:** Non-Cartesian Phase-Contrast VIPR imaging has been demonstrated to provide 4D flow MRI with large volumetric coverage and high spatial resolution [1,2]. However, adoption into clinical practice, maintaining acceptable reconstruction latency may be challenging, particularly when imaging with high channel count coil arrays. In addition, a robust complex coil combination algorithm is typically required for multi-channel phase contrast imaging in order to combine images into a single channel before any phase processing. To address reconstruction time, several techniques such as coil compression [3-7] have been proposed and its feasibility has been demonstrated for conventional Cartesian imaging. However, non-Cartesian coil compression is still challenging. Furthermore, a complex coil combination algorithm is still needed even when coil compression is used. Recently, a k-space based coil combination technique called Direct Virtual Coil (DVC) was developed [8] and its utility for non-Cartesian imaging has also been demonstrated [9]. Since DVC is essentially a k-space complex coil combination technique, it provides great potential to address both the computation time challenge and the need for a robust complex coil combination algorithm. The purpose of this work is to demonstrate the utility of DVC for non-Cartesian phase-contrast imaging, specifically, PC-VIPR.

**MATERIALS AND METHODS:** PC-VIPR data sets obtained from three (3) healthy subjects were used to demonstrate the feasibility of the DVC technique for PC-VIPR. Informed consent was obtained prior to all scanning. All scanning were performed on a 3.0T clinical scanner (Discovery MR750, GE Healthcare, Waukesha, WI, U.S.A.), with either an 8-channel head coil, or 32-channel head coil, or 20-channel torso array.

**RESULTS:** Figure 1(a-c) shows the PC angiographic images from the 8-channel head exam, in coronal, sagittal and axial planes, demonstrating isotropic resolution and good depiction of the vasculature. Figure 1(d) shows the magnitude of the derived coil combination images. Figure 2 shows the PC angiographic images from the 32-channel head exam. Figure 3 shows the average velocity images along X, Y and Z direction from the 20-channel liver exam. Since velocity images are proportional to the phase difference between the flow-encoding images, this demonstrates DVC’s capability of performing coil combination with preserved phase.

**DISCUSSION AND CONCLUSION:** In this work, we demonstrated the feasibility of using DVC combination for non-Cartesian phase sensitive applications, specifically PC-VIPR. While there are some disadvantages with the non-Cartesian DVC approach proposed in Ref. [9], such as the increased combined kernel size that lessens computational advantage to combining multi-channel data onto a single grid, the capability of performing coil combination with preserved phase is essential to reduce the channel dimension before any phase processing and speed up the reconstruction.