Accelerating Generalized Phase-Contrast MRI

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Data undersampling is a key strategy in time-resolved flow encoded phase-contrast (PC) MRI to achieve appropriate spatiotemporal resolution within an acceptable scan time. Scan time reduction is of major importance in particular for multi-point or *generalized* encoding techniques, which would require scan times in access of 20-30 min with conventional approaches and are hence prohibitive in a clinical setting.

While PC MRI allows assessing mean velocity per voxel, multi-point encoding methods are able to resolve the distribution of velocities within a voxel by sampling additional encoding points along the velocity directions (k_v) (1). To this end, the velocity encoding gradients are varied to probe a range of k_v-points. One major advantage of multi-point encoding is the ability to quantify the energy stored in both mean and turbulent velocity fields (2). In addition, by sampling multiple k_v-points, phase aliasing can be corrected and the overall sensitivity of PC MRI is increased for a wide range of mean and turbulent velocities in combination with Bayesian processing (3).

In this presentation it is demonstrated that spatial, temporal and velocity correlations can be efficiently exploited to accelerate generalized phase-contrast MRI. Examples of Cartesian and Radial undersampling strategies are presented and corresponding image reconstruction techniques are discussed (3,4). Applications of the techniques to quantify hemodynamic parameters in patients with heart valve insufficiencies highlight the utility of the methods (Figure).

(1) Moran PR. Magn Reson Imaging 1982;1(4):197-203.

(2) Dyverfeldt P, Sigfridsson A, Kvitting JP, Ebbers T. Magn Reson Med. 2006 Oct;56(4):850-8.

(3) Binter C, Knobloch V, Manka R, Sigfridsson A, Kozerke S. Magn Reson Med. 2013 May;69(5):1337-45.

(4) Santelli C, Schaeffter T, Kozerke S. Magn Reson Med. 2013 Nov 20.

Healthy Subject **Stenosis Patient**

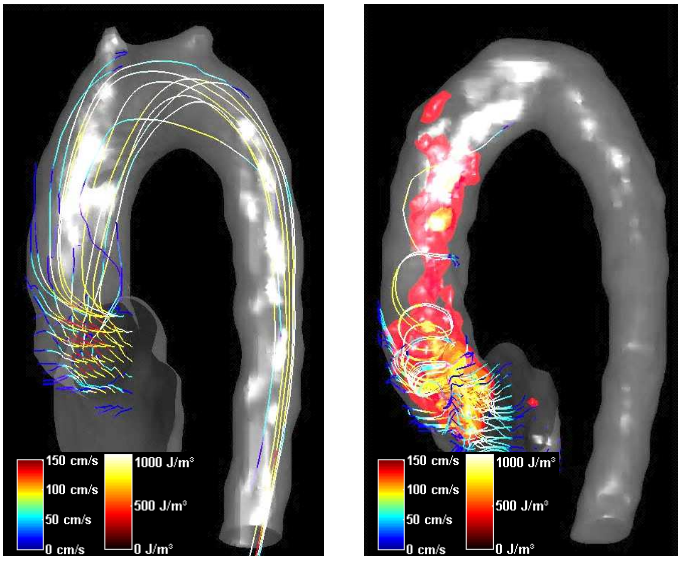

Figure: Data demonstrating accelerated MR based assessment of mean and turbulent kinetic energy in a healthy subject (left) and in a patient with a stenotic aortic valve (right). Turbulent flows downstream of the stenotic valve give rise to fluctuating velocities and corresponding turbulent kinetic energy given in [J/m^3], which is illustrated by the red shades in the aortic vessel of the patient (right).