ACCELERATING CINE FLOW MEASUREMENT WITH *k-t* BLAST & *k-t* SENSE

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Introduction

MR phase-contrast velocity mapping holds considerable promise for evaluating flow-related physiology and pathophysiology. The approach is non-invasive and it can localize vectoral flow information in 3D with high spatial resolution. Extensions of this principle can be used to measure acceleration and other forms of motion. However the clinical applicability of such techniques is limited by the relatively long scan time For example, to quantify flow along one direction, at least two scans are needed to differentiate the flow-induced phase changes from the background phase of the image, unless certain simplifying assumptions are made. In the case of 3D flow, at least four scans are needed. As a result, the overall scan time is increased significantly. By shortening the acquisition time the scan might fit within a breathhold, so that respiratory motion artifacts can be eliminated. Shortening scan time also makes flow quantitation under stress conditions more feasible.

Methods

New methods for accelerating dynamic imaging have been developed, called *k-t* BLAST and *k-t* SENSE [1]. These methods are based on the observation that the raw data in image series exhibit considerable spatiotemporal correlation. As a result, it is possible to acquire only a subset of the data and recover the missing portion afterwards. *k-t* SENSE is similar to *k-t* BLAST, but it additionally takes into account the spatial encoding effect of coil sensitivity, if multiple coils are used for signal reception.

The *k-t* approach makes use of the observation that the signals in a image series can be compressed into a more compact format in *x-f* space, due to the inherent correlation (Fig. 1). Here, *x* and *f* represent spatial coordinates and temporal frequencies, respectively. As a result of this compression, significant portions of *x-f* space are hardly used, since they contain almost no signals. Thus, those portions can be re-used to allow for significant acceleration of the data acquisition

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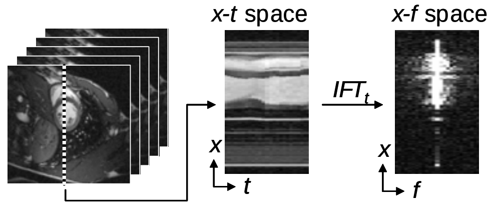
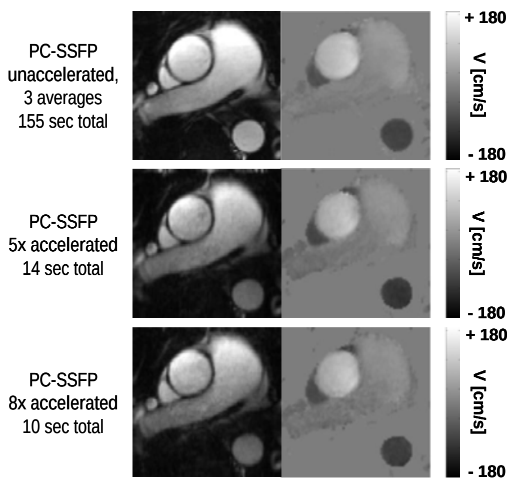


Figure 1: Left to right: a cine series of short-axis images; x-t space representation showing one pixel column at different time points (i.e. cardiac phases); x-f space representation showing one pixel column at different temporal frequencies.

Results

Fig.2 shows results using this approach. The upper figure shows anatomical (left column) and velocity (right column) images of the ascending aorta during peak systole. Data were acquired with a phase-contrast (PC) sequence. The three rows from top to bottom show the unaccelerated images with 3 averages to reduce artifacts from respiratory motion, and the 5x and 8x accelerated images, each acquired in a single breathhold. The results demonstrate good image quality and excellent correspondence, despite a scan-time reduction from 155sec to 14sec and 10sec, respectively. The lower figure shows the quantitative agreement among the calculated volume flow curves.



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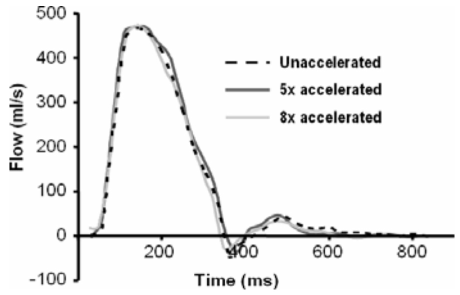

Figure 2: Anatomical (left) and velocity (right) images of the ascending aorta at peak systolic frame; calculated flow profiles for different acceleration factors.

Discussion

k-t BLAST and *k-t* SENSE permit up to 8-fold acceleration in cine flow measurements. This high degree of acceleration not only makes common phase-contrast measurements more practical; it also brings more sophisticated flow measurements towards a clinically relevant realm.

References

[1] TSAO, J. et al. MRM 50:1031-42 (2003).