ADAPTIVE CENTRIC VIEW ORDERING FOR MAGNETIZATION PREPARED GRADIENT ECHO IMAGING

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INTRODUCTION: Magnetization prepared gradient echo sequences are routinely used for T1 weighted isotropic brain imaging to enhance gray-white matter contrast. Views are ordered such that a fixed number of phase-encodes in a single kx-ky or kx-kz plane (Fig.1) are collected in a segmented centric or sequential fashion after an IR pulse is applied followed by an optional delay for magnetization recovery [1]. For large matrices, a segmented acquisition allows a single kx-ky or kx-kz plane to be acquired in an integer number of cycles, however a 1D trajectory through ky-kz space is limiting since only certain segment sizes are allowed based on the prescribed matrix size. This work improves the efficiency of magnetization prepared brain imaging by introducing an adaptive centric view ordering. In addition to decoupling the train length from the matrix size, it also allows desirable time saving strategies such as k-space corner removal [2] and 2D auto-calibrated acceleration with non-separable grid [3] (Fig 2a) which are not possible with conventional view ordering, since the number of views from one kx-ky or kx-kz plane to the next varies.

METHODS: *View Ordering Technique*—The proposed approach partitions k-space into segments, as shown in Figure 2b. A reduced number of views are needed with 2D auto-calibrated acceleration (2x2 acceleration with a small fully sampled region in the center) and 22% k-space corner removal. The proposed technique assigns all views to segments based on angle, and orders views within segments based on radius with respect to the ky-kz origin. For IR prepared brain imaging, this segmented 2D-centric approach is preferred to optimize contrast given there is no recovery delay in our implementation. One can also combine conjugate symmetric segments into the same shot by alternating view ordering between conjugate pair. Interleaved elliptic centric ordering also accomplishes the same task [3] and has demonstrated favorable results.
Volunteer Experiments—Healthy volunteers were scanned on a 1.5T scanner (Signa® HDx, GE Healthcare, Waukesha, WI) with an 8-channel receive-only head coil (TI=450ms Flip=20 BW=31 kHz). An acquisition matrix of 224x224x192 yielded 0.86x0.86x1.0 mm^3 voxels before interpolation. The standard 1D-centric and proposed 2D-centric view ordering techniques were compared with various partial-Fourier and parallel imaging acceleration settings.

RESULTS: Figure 3A shows the fully sampled dataset without partial Fourier acquisition (9:59 min). Fig 3B was acquired using half-Fourier with homodyne combined with acceleration of 2 in phase direction (3:13 min). Fig 3C demonstrates the new view ordering fully sampled acquisition with 22% corner removal (6:29 min). Fig 3D shows the new view ordering acquisition with phase acceleration factor of 2 and 22% corner removal (3:16 min). Improved contrast is visible despite being shorter or equivalent duration scan.

DISCUSSION & CONCLUSION: The proposed view-ordering has three important advantages: 1) it improves contrast by providing acquisition scheme that is centric in both ky and kz dimensions, 2) it enables a flexible segment size that is decoupled from the acquisition matrix size and 3) it enables the use of k-space corner removal and a non-separable auto-calibrated acceleration. With 2D centric segmentation, the advantage of the optional recovery delay period is reduced, as points that contribute to the image contrast most will be captured first and those that contribute the least will be collected last. Larger segment size will further reduce scan time at the expense of increased modulation which might be observed as increased blurring and/or reduced contrast.

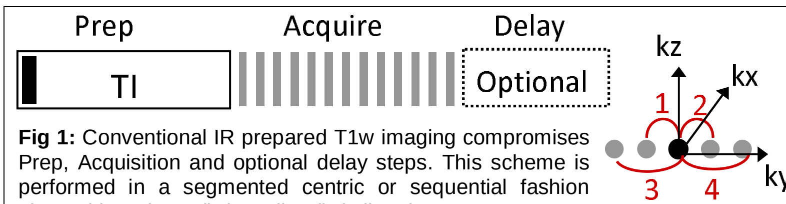

Fig 1: Conventional IR prepared T1w imaging compromises Prep, Acquisition and optional delay steps. This scheme is performed in a segmented centric or sequential fashion along either phase (ky) or slice (kz) direction.

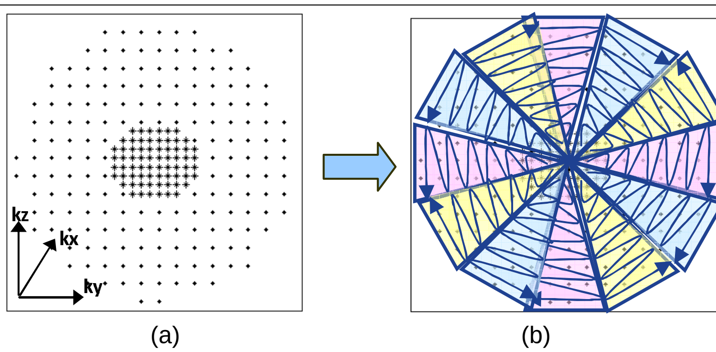

Fig 2: a) 2D auto-calibrated non-separable sampling pattern with corner removal; cannot be realized with the standard view ordering. b) Proposed view ordering provides the flexibility to handle arbitrary sampling patterns mapping segments in kx-ky-kz space.

REFERENCES: 1.Mugler et al US5245282 2. Bernstein et al JMRI 2001;14. 3. Beatty et al ISMRM 2007, 1749. 4. Tan et al ISMRM 2007 #1762.

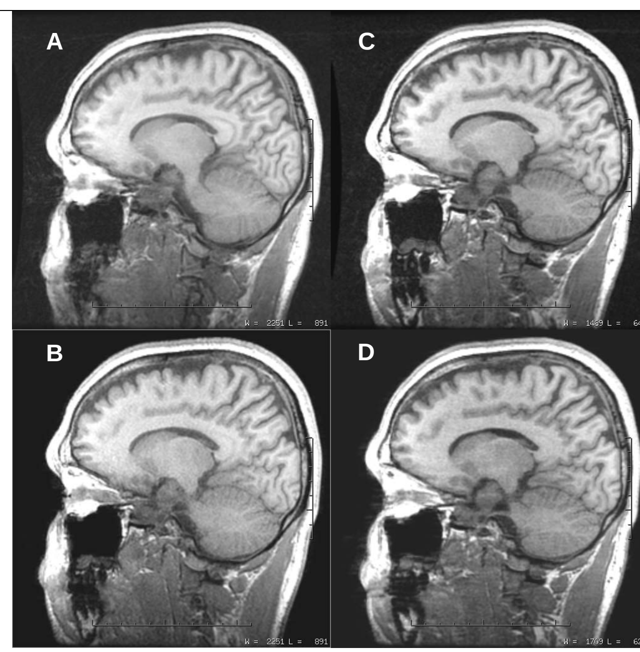

Fig 3: Standard centric view ordering with full k-space sampling (A) and with parallel imaging and half-Fourier (B) versus new view ordering with full k-space sampling with 22% corner removal (C) and with parallel imaging plus 22% corner removal (D)