Motion-Corrected MRA using Variable Pitch PROPELLER

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Introduction: Variable Pitch PROPELLER MRA[1] is a compilation of PROPELLER[2] and quadratic phase encoding[3] which improves upon conventional TOF MRA by reducing artifact due to motion and increasing scan efficiency.

Procedure: A 2D TOF sequence on a GE 1.5T EXCITE scanner was modified to collect data in PROPELLER blades(Fig. 1a), with the following parameters: TR 4.4ms, 20^o flip angle, 320 diameter matrix, 64 slices, 125kHz bw, 24cm FOV, scan time 4min 30sec. The views are collected asymmetrically and must be rotated 360^o to sample all of k-space. Quadratic encoding was added to increase slab width by a factor M, creating slice overlap and increasing SNR by $M^{1/2}$. As outlined in [3], this overlap can be subsequently removed to regain the original resolution but maintain the added SNR, creating an SNR vs. inflow tradeoff similar to that of MOTSA TOF. As seen in Fig. 1(b,c), partial refocusing of the slice select gradient creates a shifted parabolic phase in each excited slab, whose vertex is on the top or bottom of the slab depending upon the direction of the RF frequency sweep. This in turn affects sensitivity to flow direction, since the vertex of the parabolic phase is analogous to the center of k_z space, while the edge of the parabolic phase is analogous to high k_z.[3].

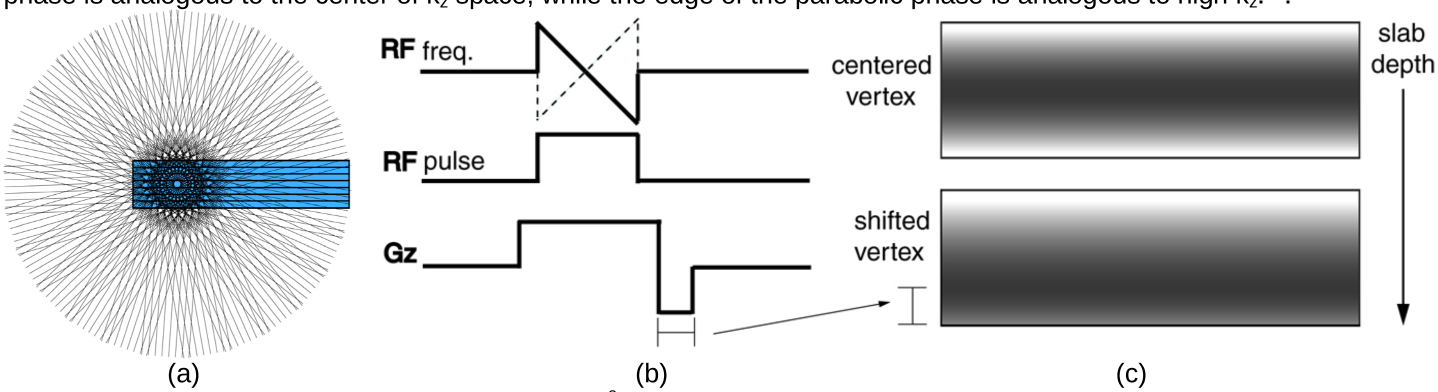

Fig.1 Asymmetric PROPELLER blade (blue) rotated 360^o to cover k-space(a), pulse sequence diagram highlighting quadratic encoding and vertex refocusing in the slice direction(b), and resulting slab profile with centered and shifted parabolic vertex of phase(c).

Discussion: PROPELLER offers many artifact-reducing benefits, including (1) correction of rigid body motion, (2) correlative weighting to remove other motion-corrupted data, and (3) radial sampling which disburses remaining artifacts(2). Quadratic encoding increases the SNR [Fig. 1(b-d) vs. Fig 1a]. Figure 1b vs. Fig. 1(c,d) illustrate how venous vs. arterial flow is enhanced depending upon the direction of the rf frequency sweep (up vs. down, respectively). Tissue in Fig 1(b,d) is more saturated than in Fig. 1c due to the relative direction of slab movement vs. frequency sweep.

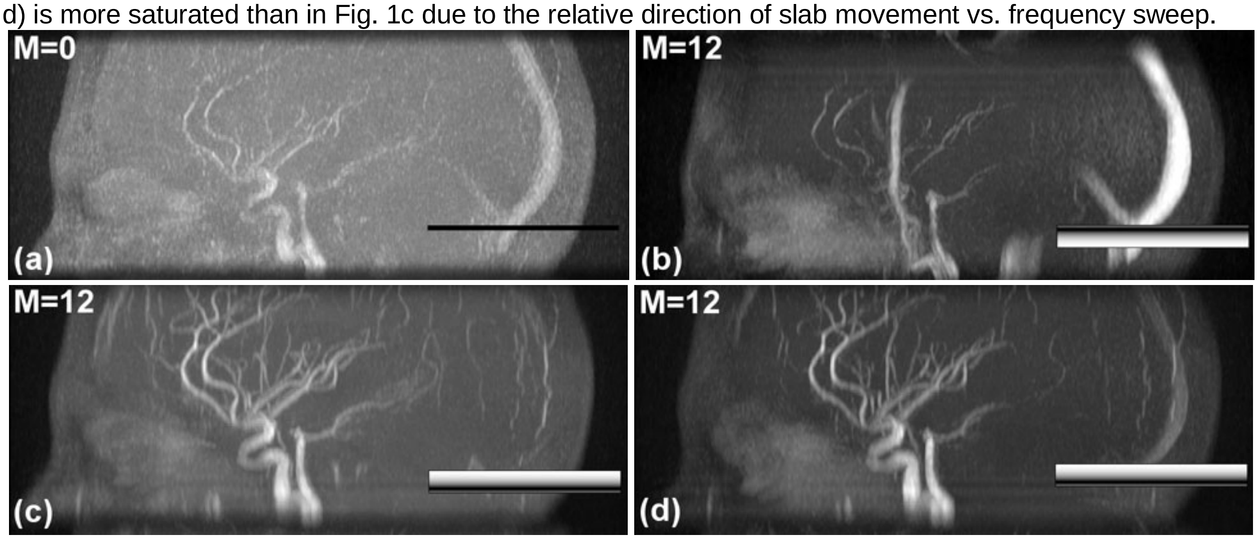

Fig.2 MIP's of images from a volunteer, with slab type and position of phase vertex (black) indicated by the bar on the lower right of each image. Data show images with M=0 (a) and M=12 (b,c,d), rf sweep upward (b) and downward (c,d), and slab movement downward (a,b,c) and upward (d). Void of quadratic encoding, data in (a) is similar to 2D TOF.

REFERENCES: 1. Abstract submitted to this meeting. 2. Mag Res Med; 42:963. 3. Mag Res Med; 41:309.
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