PROPELLER MRI at 7T

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PURPOSE

The utility of the k-space trajectory known as PROPELLER (General Electric) a.k.a. BLADE (Siemens) a.k.a. MULTIVANE (Philips) to compensate for motion in neuro imaging at clinical field strengths is well known [1]. In this work, the static image quality of multivane is explored on a 7T human scanner for several sequences including 2D T2-weighted turbo spin echo (2D T2W TSE), 3D T1-weighted turbo gradient echo (3D T1W TFE), and 3D T2*-weighted gradient echo (3D T2* FFE).

METHODS

A software patch for the collection of multivane data on a clinical 3.0T Achieva (Philips Medical Systems - Best, The Netherlands) [2] was ported to the 7.0T Achieva (Philips Medical Systems - Cleveland, Ohio, USA) and used to image 3 male subjects who gave proper informed consent under IRB approval. The subjects remained motionless while cartesian and multivane scans were performed. Multivane images were reconstructed on the scanner's console computer using ReconFrame (Gyrotools Inc., Zurich, Switzerland). No motion correction algorithm was applied. After removal of low-pass filtered spatial domain phase (linear and non-linear) from each vane, ReconFrame's built-in gridder function was used to resample the multivane k-space data onto a cartesian grid before inverse Fourier transformation to the spatial domain. K-space sampling density compensation weights were calculated directly using the known geometry of the vanes [3]. Table 1 provides more details of the performed protocols.

Table 1. 7T cartesian and Multivane acquisition parameters

	2D T2W TSE	3D T1W TFE	3D T2* FFE
Matrix Size	512	512	512
TR/TE (msec)	9976/115	5.6/2.9	32/19
k-space lines/vane	24 (= TSE factor)	128 (=TFE factor)	24 (no turbo factor)
number of vanes	34	7	34
Cart./Multivane scan time (m:ss)	5:22 / 7:56	5:11 / 9:05	5:44 / 9:15

RESULTS AND CONCLUSION

Figure 1 shows that 7T multivane images of static neuro anatomy have comparable contrast and quality when compared to the equivalent cartesian images, however, the multivane images appear smoother in most cases – most likely due to inherent properties of the point spread function of the multivane k-space trajectory. The multivane images could potentially be sharpened by applying a motion correction algorithm or by more advanced phase correction of each vane. As expected from the rotating frequency encode direction of the multivane trajectory, the appearance of susceptibility artifacts is different for the two methods – sometimes favoring cartesian and sometimes favoring multivane. Nyquist-sampled multivane acquisitions come at a price of increased scan time, i.e. at least 157% (π/2 * 100%) times the fully sampled cartesian equivalent. Because high resolution anatomical imaging is likely to be a primary 7T application, the extra scan time may be justified in the cases when multivane images reconstructed using a motion correction algorithm allow visualization of structures that are not visible on the cartesian equivalent due to even slight subject motion. Future studies are necessary to evaluate the motion compensation ability of multivane acquisitions at high field strengths such as 7T.

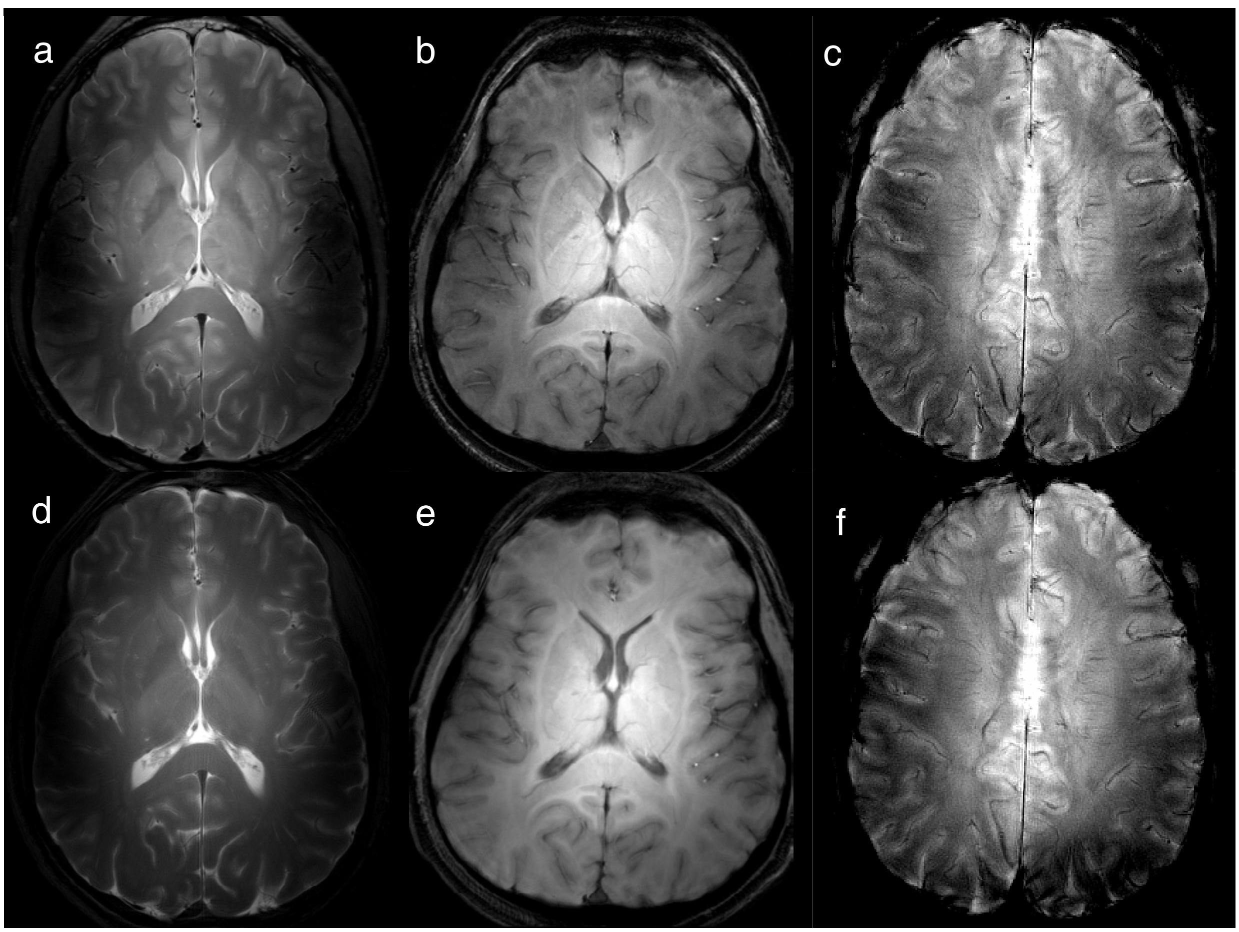

Figure 1. Example cartesian (a,b,c) and multivane (d,e,f) images for 2D T2 weighted turbo spin echo (a,d), 3D T1 weighted turbo gradient echo (b,e), and 3D T2* weighted gradient echo (c,f) pulse sequences. In most cases, the multivane image appears smoother than the cartesian equivalent – a potential drawback of the point spread function of the multivane k-space trajectory. Also, the appearance of susceptibility artifacts is different for the two methods – sometimes favoring cartesian and sometimes favoring multivane.

REFERENCES 1. Pipe, MRM 42(5); 963-969 (1999). 2. Welch, Proc. ISMRM 2006; p.3207. 3. Devaraj, Proc. ISMRM 2006; p.2956.

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