Reduce blurring effects in PROPELLER QBI

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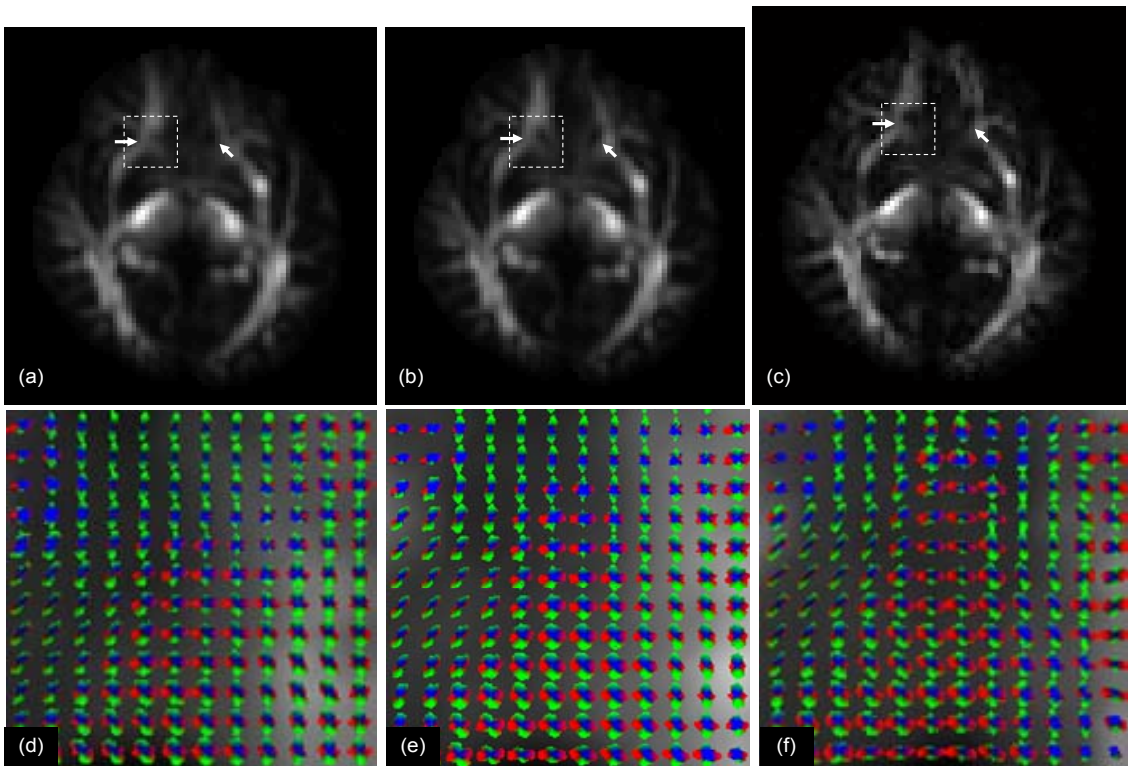
Background and purpose: Q-ball imaging (QBI) accelerated by PROPELLER EPI acquisition was demonstrated to be scan-time efficient and less susceptibility distortions [1]. In PROPELLER QBI, the reconstruction is based on keyhole technique which shares outer k-space with other blade DWIs for high resolution but preserves central k-space for diffusion contrast [2]. Although susceptibility distortion is substantially reduced by PROPELLER EPI acquisition [3, 4], the residual susceptibility distortions of blade DWIs will cause blurring effects in reconstructed PROPELLER QBI. Therefore, the purpose of this study was to reduce residual distortions by incorporating image registration in PROPELLER QBI reconstruction.

Material and methods: In this study, data were collected from a healthy volunteer aged 27 y/o on a 3T MR system (Philips Achieva, Netherlands, Best) using eight-channel phase array head coil. PROPELLER QBI data were acquired by short-axis PROPELLER EPI with 75% reduction of frequency encoding and 25 degree rotation between blades. The acquired 252 icosahedral diffusion directions were separated into 18 PROPELLER sets according to their diffusion directions. Other imaging parameters were: TR/TE = 1276/120 ms, b-value = 4,000 s/mm^2, matrix size = 32x128, SENSE factor = 3, half Fourier = 0.647, FOV = 256x256 mm^2, slice thickness = 5 mm, # slice = 10, total scan time = 12:34. In addition, QBI acquired by single-shot EPI were also obtained for comparison using the same imaging parameters except for TR=1833 ms, matrix size = 128x128, and scan time = 15:23. In PROPELLER QBI, the 14 blade EPIs of each PROPELLER set were first reconstructed to a high resolution PROPELLER EPI which serves a template for co-registration of 14 blade EPIs using diffeomorphic registration [5]. The displacement maps were then used to transform corresponding blade DWIs to reduce residual distortions. Subsequently, PROPELLER QBI was reconstructed to obtain generalized fractional anisotropy (GFA) and orientation distribution function (ODF).

Results: Figs. (a) and (b) showed GFA map of PROPELLER QBI without and with image registration. In (a), due to residual susceptibility distortions, the white matter structure in frontal lobe was blurred as indicated by white arrowheads. By incorporating image registration, the blurring effects were substantially reduced in (b) showing fine structure of anterior corona radiata. In (c), GFA map obtained from conventional QBI showed elongated frontal lobe due to susceptibility distortions. The corresponding ODF maps of rectangular regions in (a), (b) and (c) were shown in Figs. (d), (e) and (f), respectively.

Conclusions: With the aid of image registration, the PROPELLER QBI will be more suitable for clinical applications for its shorter scan time, less susceptibility distortion as well as capability of resolving intra- voxel fiber crossings.



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