Propeller EPI with SENSE parallel imaging using a circularly symmetric phase array RF coil

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Introduction

Propeller imaging[1,2] with EPI has strong potential in obtaining a distortion-free diffusion tensor images by reducing the EPI echo train length (ETL) through the use of multi-shot acquisitions. Parallel imaging methods such as sensitivity encoding (SENSE) help decreasing the number of phase encoding steps and therefore allows further reduction in ETL and increases sampling speed along phase encoding direction. Propeller EPI is especially a suitable candidate for SENSE imaging when the phase array RF coil is circularly symmetric, in that the number of independent coil elements determining the maximum acceleration factor is not strongly dependent on the direction of phase encoding. In this study we use an 8-element head coil and demonstrate that a SENSE acceleration factor of up to 4 can be obtained for all rotating blades in Propeller EPI without causing prominent artifacts.

Materials and Methods

A resolution phantom underwent SENSE Propeller spin-echo EPI scans (number of blade:7, Matrix size of each blade: 64x256, rotation angle: 26 degree, FOV:220x220, TR/TE:1s/50ms, 7 shots) on a 3T scanner (8-channel circularly symmetric phase-array head coil, Siemens, Trio) using different SENSE acceleration factors (R) 1 ,2 ,2.6 and 4 . The corresponding echo train length (ETL) were 64, 32, 24 and 16, respectively. The K-space trajectory is shown in Fig. 1. The grayscale in Fig. 1 indicates the k-space sampling density of all rotated blades.

After regular EPI correction (navigator correction, read-out regridding), aliased complex images of each blade were unfolded using coil sensitivity estimated from the unaccelerated reference scan. Four 256x256 images of different accelerations were reconstructed by 7 blades with matrix size 64x256 of each image using Propeller image reconstruction algorithm[1].

Results & Discussion

Fig.2 showed the resulted resolution phantom images using SENSE Propeller EPI with different acceleration factors R=1.0, 2.0, 2.6, 4.0 accelerations. First of all, notice that the image reconstructed from R=1.0(ETL=64) was apparently more blurred than the others. This could be explained that data was distorted differently with differed phase-encoding direction in each single blade. Nevertheless, as shown in Fig.2, the blurring effect was less using higher acceleration factor (R=2.6 , R=4) which decreased ETL and increased sampling speed along phase-encoding direction.

In addition, notice that little unfolding ghost was found in both images(R=2.6 , R=4) .Due to the nature of Propeller trajectory, the phase-encoding direction in which the unfolding ghost appears is different in each single blade. This inherently suppresses the unfolding ghost. On the other hand, SENSE aliasing changes in different blades, leading to more homogeneous geometry factor map due to image reconstruction from different blades. This is particularly noticeable in a circularly symmetric array RF coil.

In summary, we have already shown that less distorted 256x256 high resolution images could be acquired using SENSE propeller EPI with 7 shots and relatively shorter 16~24 echo train length. Further study on the application to high resolution diffusion image is currently undergoing.

References

1.Pipe J, MRM 42(5): 963-62,1999. 2.Pipe J, et al., MRM 47(1): 42-53,2002.

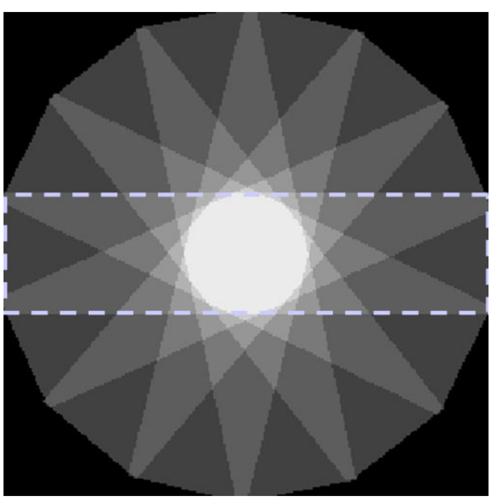

Fig.1 showed PROPELLER EPI k-space trajectory using 7 blades. The grayscale in the figure indicated the k-space sampling density of the combination of all rotated blades.

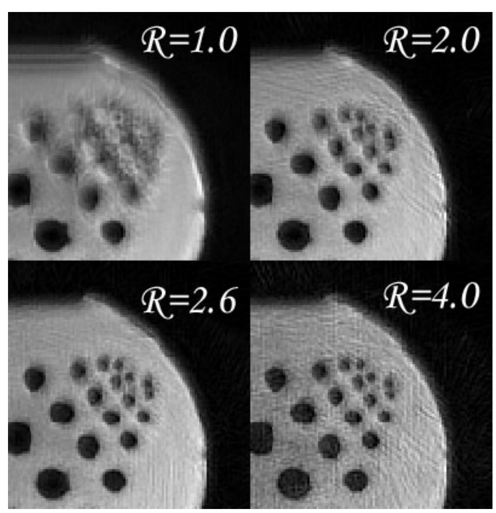

Fig.2 Resolution phantom comparison at SENSE R=1.0, R=2.0, R=2.6, and R=4.0 accelerations. The corresponding echo train length were 64, 32, 24 and 16.