Anatomical details in brainstem and cisterns revealed by RESOLVE with unidirectional MPG; comparison with single-shot EPI diffusion weighted image

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Introduction

High resolution diffusion weighted images (HR-DWI) for the visualization of detailed anatomy of brainstem and cranial nerves has been tried using multi-shot diffusion sequences such as propeller type acquisition or read-out segmented multi-shot EPI (RESOLVE). Those are usually performed as diffusion tensor imaging (DTI) with numerous numbers of MPG directions, therefore scan time for these DTI acquisition is usually quite long and mis-registration by distortion or motion between the scans with different MPG directions obscured the small structures. DW-neurography using unidirectional MPG and single-shot EPI has been proposed as a robust technique for the brachial or sacral plexus visualization utilizing the lack of mis-registration between the images with different MPG directions. SNR time-efficiency of of single-shot EPI is excellent, however single-shot EPI suffers severe distortion near bone and air. The purpose of the present study is to compare the visibility of small structures in brainstem and cisterns between the images with RESOLVE and those with single-shot EPI both using unidirectional MPG..

Methods

Four patients with vertigo/hearing loss underwent MR exam for inner ear pathology (M:F=3:1, Age 40-74). The protocol also includes DWI of brain stem. No patients showed any abnormality in brainstem and cranial nerves in cisterns on MR images. All scans were performed on 3T unit using 32 channel array head coil. Scan parameters were as follows. RESOLVE; Axial slices, TR3800, TE80, 4nex, 12-4mm thick slices with 0.4mm gap, 320x256 matrix, b=700s/mm^2 only in slice direction (S-I), GRAPPA x 2, segment 21, FOV163mm, 6min37sec. The technique is based upon the readout-segmented EPI method [1], which has been modified to incorporate 2D navigator phase correction [2] and navigator-based reacquisition [3]. A published detailed description of the technique can be found in [4]. Single-shot EPI; Axial slices, TR3800, TE102, 32nex, 12-4mm thick slices with 0.4mm gap, 192x192 matrix, b=700s/mm^2 only in slice direction (S-I), GRAPPA x 2, FOV220mm, 2min15sec. Images were evaluated by a neuroradiologist regarding the visualization of fine structures on positive or negative basis; decussation of superior cerebellar peduncle (DeSCP), SCP at the level of pons (pSCP), medial and lateral lemniscus (ML, LM), scattered corticospinal tract between transverse fibers in pons (pCST), medial longitudinal fasciculus (MLF), CST in medulla oblongata (mCST), reticular formation (RF), cranial nerve (CN) III, V, and VII&VIII complex.

Results

Visibility was listed on Table 1. Visibility was significantly better on RESOLVE for pCST, mCST, CN VII and VIII complex, MLF, and LL ($p<0.001$) **(Fig)**.

Conclusions

RESOLVE with uniderectional MPG can be obtained in clinically acceptable scan time and might be a robust method to visualize fine structures in brainstem and cisterns. Moderate T2-weighted contrast and signal suppression of tracts parallel to S-I direction synergistically contribute to the excellent visualization of fine anatomical structures as shown in the present study.

References

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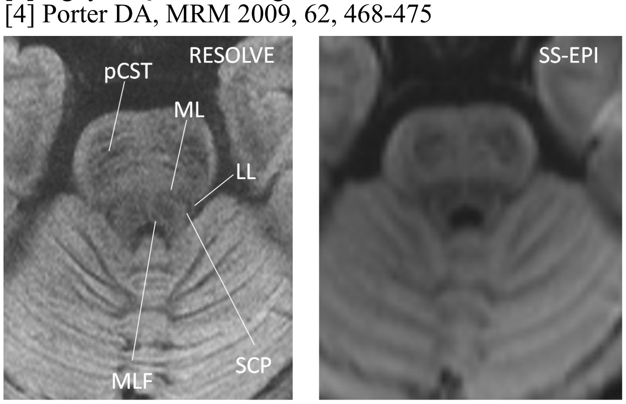

Fig. High resolution DWI by RESOLVE (left) and standard DWI by single-shot EPI (right). MRG was applied only in slice (z) direction with b=700 s/mm^2. Scattered pCST, ML, LL, SCP and MLF are clearly demonstrated on RESOLVE, however these are blurred on SS-EPI.

Table 1 Visibility of fine structures (n=4x2)

	RESOLVE	SS-EPI
decussation of superior cerebellar peduncle in midbrain	8/8	8/8
superior cerebellar peduncle in pons (SCP in pons)	8/8	6/8
medial lemniscus (ML)	8/8	4/8
lateral lemniscus (LL)	8/8	0/8
scattered corticospinal tract fibers in pons (sCST in pons)	8/8	0/8
medial longitudinal fasciculus	8/8	0/8
reticular formation (RF)	8/8	8/8
CST in medulla oblongata (CST in medulla)	8/8	0/8
cranial nerve III	6/8	6/8
cranial nerve V	8/8	8/8
cranial nerve VII and VIII complex	8/8	0/8