

# Reproducibility of apparent diffusion coefficient values at hippocampus measured by high-resolution readout-segmented DWI vs. Single-shot DWI with 2DRF excitations.

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**Introduction:** Readout-segmented EPI with 2D navigator-based reacquisition has realized high-resolution diffusion-weighted imaging (RS-DWI) with reduced susceptibility artifact and blurring from T2 signal decay compared to single-shot EPI [1,2]. In single-shot EPI, however, inner-FOV DWI acquisition by using 2DRF excitations (2DRF-DWI) has been introduced as an alternative approach that enables reduced distortions and high resolution with shorter data acquisition time, when region of interest (ROI) is limited [3]. Both DWI sequences are work in progress provided by Siemens. DWI may reflect early degenerative tissue changes in the brain as signal intensity differences, or more quantitatively as apparent diffusion coefficient (ADC). One of areas of clinical interest is the hippocampus that is located near the skull base and has complicated structure, but is highly important for diagnosis of Alzheimer's disease as well as for evaluation of epileptic foci in temporal lobe seizures [4]. ADC measurement of hippocampus, however, is prone to artifacts owing to its location and consistent result is not necessarily obtained [5]. Therefore, we designed a study to investigate reproducibility of ADC measurements at hippocampus by adopting two new methods and compared their performance.

**Methods:** RS-DWI and 2DRF-DWI images of the hippocampus were acquired in para-coronal orientation for 10 healthy subjects (9 males, 1 female, age range: 24-35 years, average 26 years old) after obtaining written informed consent by using a 3T scanner (MAGNETOM Trio, A Tim System, Siemens Healthcare, Erlangen, Germany) with a 32-channel head coil. Scan parameters for RS-DWI were: field-of-view (FOV) 135mm, matrix 160×160, in-plane resolution 0.8×0.8mm, slice thickness 3mm, number of slices 24, TR 5500ms; TE 74ms and readout segments 15, scanned in 5min 43sec. For 2DRF-DWI, FOV and matrix were reduced by half in phase direction, resulting in the same pixel resolution. Slice thickness and number were also the same. Other parameters were: TR 5500ms; TE 80ms, parallel imaging factor 2, and 8 averages in 3min 13 sec. Motion-probing gradients were separately applied in orthogonal 3 directions with  $b=1000\text{s/mm}^2$  and  $b=0\text{s/mm}^2$ . As an anatomical reference, T2-weighted images (T2WI) were also acquired with FOV 200×200, TR 3500ms, TE 79ms, matrix 448×448, in-plane resolution 0.4×0.4mm, slice thickness 3mm for the same number of slices. These measurements were repeated twice. The subjects got off the scanner table between two sessions. Both RS-DWI and 2DRF-DWI images were coregistered to T2WI by using SPM8. ROIs were drawn on T2WI separately for left and right hippocampus in each subject by using MRIcro and applied to both DWI images to measure ADC values. For the repeated measurement pairs of ADC values, coefficients of variation (CV) were calculated and statistically compared by using paired *t*-test. A *P* value < 0.05 was considered significant.

**Results:** ADC values at hippocampus were  $0.881 \pm 0.027 \times 10^{-3} \text{ mm}^2/\text{s}$  (mean  $\pm$  standard deviation) and  $0.463 \pm 0.039 \times 10^{-3} \text{ mm}^2/\text{s}$ , respectively for RS-DWI and 2DRF-DWI. There was a large difference between two methods. The CV of ADC values were  $1.82 \pm 1.12$  and  $2.42 \pm 1.36$  %, respectively. Representative images acquired by using two methods are illustrated in Fig. 1. The CV of RS-DWI was smaller than that of 2DRF-DWI, although both was very low and no significant difference was observed (Fig.2).

**Discussion:** Clinical applications of DWI and ADC measurement for disorders involving hippocampus, such as Alzheimer's disease and temporal lobe epilepsy, are expected to have highly important values for not only patients but also aging population in general. This, in turn, requires reasonable reproducibility in acceptable scan time, which we consider to be around 5 minutes. Higher resolution and signal-to-noise (SNR) might be attainable if longer scan time is allowed, which may not be practical for wide clinical applications. Although within these limitations, highly reproducible result was obtained in the RS-DWI measurement. The 2DRF-DWI resulted in higher but relatively reliable CV values. However, 2DRF-DWI had much lower ADC values than RS-DWI. It might be due to apparently lower SNR, which made signal intensity of B1000 images reach to noise level (i.e. no lower pixel values). Therefore, RS-DWI might be the better choice for clinical practice.

**References:** [1] Porter et al. MRM 62:468-75(2009); [2] Holdsworth et al. MRM 62:1629-1640(2009); [3] Finsterbusch. JMRI 29-987(2009); [4] Yoo et al., AJNR 23:809-812(2003); [5] Ramani et al., Radiology 241:26-44(2006).

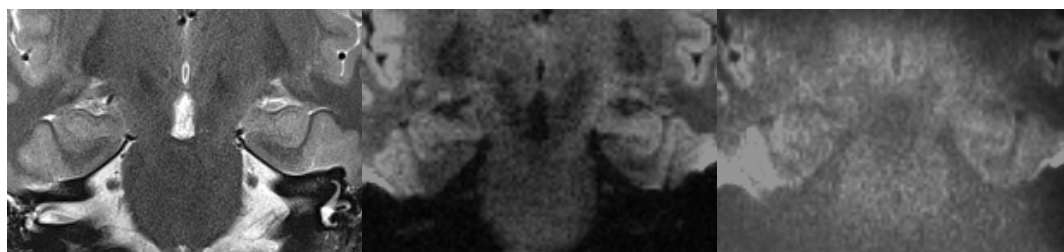


Fig 1. Representative images : (Left) T2WI, (Center) RS-DWI and (Right) 2DRF-DWI.

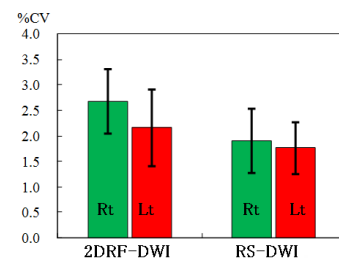


Fig 2. CVs of ADCs at hippocampus.