IN VIVO IDENTIFICATION OF HUMAN OPTIC RADIATION AND STRIA OF GENNARI USING HIGH-RESOLUTION PHASE DIFFERENCE ENHANCED IMAGING AT 3 TESLA

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Target Audience: Ophthalmologists and neuroscientists

Purpose: Phase difference enhanced (PADRE) imaging technique uses three-dimensional (3D) principle of echo shifting with a train of observations (PRESTO) which can selectively enhance the phase difference between the targets and surrounding tissue (1). Our purpose is to evaluate the findings of the optic radiation and the myelinated layers in striate cortex (stria of Gennari) in vivo using PADRE and measure the phase values in optic radiation and striate cortex.

Methods: Thirty-five healthy volunteers (19 males and 16 female; age range 21–50 years; mean age, 30.2 years) were examined using highresolution PADRE with a 3T MR system (Achieva 3.0T TX; Philips Healthcare, the Netherlands). Axial and coronal PADRE images were acquired covering the entire optic radiation and occipital lobe. The sequence was performed with following parameters: TR/TE= 32 /49 ms; FA = 10° ; FOV = 21 x 21 cm; Matrix = 512 x 512; NSA= 1; in-plane resolution = 0.45×0.45 mm². The total acquisition time was approximately 15 minutes. DTI data were also acquired and used as a reference to delineate and locate the optic radiation for PADRE images. PADRE and susceptibility weighted imaging (SWI)-like images were reconstructed from the magnitude and phase images. Two radiologists blindly and independently evaluated delineation of two layers at the optic radiation (internal sagittal stratum and external sagittal stratum) and the stria of Gennari in striate cortex in PADRE and SWI-like images using a four-point grading scale. Moreover, phase values were measured and calculated on high-pass filtered phase images.

Results: In all 35 healthy subjects, optic radiations in PADRE images corresponded well with the fiber track results of DTI and clearly showed the two layers of the optic radiation (grade 3) (Figure 1A), which were difficult to be detected in SWI-like images (grade 0) (Figure 1B), and there was no discrepancy between observers. The hypointense lines (stria of Gennari) were seen in all bilateral primary visual cortexes. The mean scores were 2.71 ± 0.46 , and 1.54 ± 0.50 on PADRE and SWI-like images respectively. Inter-observer agreement was good (κ =0.759). The phase values of internal sagittal stratum (ISS), external sagittal stratum (ESS) and striate cortex are 0.139 ± 0.142 , 0.451 ± 0.105 , -0.210 ± 0.089 radians at the left, and are 0.162 ± 0.123 , 0.431 ± 0.124 , -0.215 ± 0.080 radians at the right, respectively. There were no statistical differences between the bilateral structures (p=0.239, 0.313 and 0.757, respectively), but phase values between ISS and ESS demonstrated significant differences (p=0.000). **Discussion:** Histologically, stria of Gennari is a band of myelinated nerve fibers in layer IVb of primary visual cortex, besides, the ESS has larger axons and thicker myelin than the ISS, which probably account for their different signal intensities and phase values in PADRE images. **Conclusion:** The PADRE technique can differentiate the two layers of the optic radiation and identify the stria of Gennari, which, at least in part, seems to be associated with differential myelin content. The improved contrast in PADRE images may provide a novel tool for the diagnosis of diseases that affect the optic radiation and primary visual cortex.

References:

1.T. Yoneda TH, et al. Proc. Intl. Soc. Mag. Reson. Med. 2009, 17:2764.



Fig 1

Fig 2

Fig. 1 A comparison of axial phase difference enhanced (PADRE) image (A) and susceptibility weighted imaging (SWI)-like image(B) from a healthy volunteer .On PADRE image, the triple-layer appearance ---outer hyperintense, middle hypointense(stria of Gennari) and inner hyperintense layers in primary visual cortex(long arrows) were clearly identified; the inner median-signal-intensity layer (internal sagittal stratum) and outer low- signal-intensity layer (external sagittal stratum) were clearly seen parallel to the wall of the lateral ventricle(arrow ahead).The distinction between internal sagittal stratum and external sagittal stratum was difficult to detect on SWI-like image. Fig.2 Coronal PADRE images displayed the optic radiation running lateral to the inferior horns of both lateral ventricles through the temporo-occipital lobes (A-D arrows), and Meyer loops also clearly identified (A and B).