Feasibility of T1rho MR imaging in identification of the epileptogenic zone in patients with mesial temporal lobe epilepsy

X Li[1], V Lai[1], Q Chan[2], RSK Chang[3], HKF Mak[1], and W Mak[3]

[1]*Department of Diagnostic Radiology, The University of Hong Kong, Hong Kong, China,* [2]*Philips Healthcare, Hong Kong, China,* [3]*Queen Mary Hospital, Hong Kong, China*

Target audience: Neurologist, epileptogist, neuroradiologist

Purpose: T1rho is sensitive to physiochemical exchange and early molecular changes. We aim to investigate the feasibility and utility of T1rho MR imaging in identification of epileptogenic zone in patient with mesial temporal lobe epilepsy (MTLE).

Methods: 7 patients (male 28.6%, female 71.4%; mean age of 36.29±8.77 yrs) with established MTLE (typical seizure semiology and EEG findings) and MR proven hippocampal sclerosis were recruited into patient group. 7 normal healthy and age-matched subjects (male 42.9%, female 57.1%; mean age of 36.14±5.18 yrs) were recruited as control group. Conventional structural (3D MPRAGE T1W, coronal oblique TSE T2W, FLAIR T2W, SWI T2*W) and functional (T2 relaxometry and T1rho) MR imaging were performed on a 3.0-T MR scanner utilizing a head coil. Image analysis for T1rho imaging was performed on in-house software developed in IDL 6.3 and fitted on a pixel-by-pixel basis. Region of interest (ROI) was manually drawn by a neuroradiologist to outline the amygdala (AM), hippocampal head (HH), hippocampal body (HB) and hippocampal tail (HT) on both sides of each subject. ROI was contoured on T2W images and subsequently co-registered to T2 relaxometry and T1rho images for analysis. T2 relaxometry and T1rho values were obtained with their respective left/right asymmetric ratio calculated. Visual assessment of hippocampal volume was also made to denote the presence or absence of atrophy. The obtained T2 relaxometry and T1rho asymmetric ratios in normal subjects were used as endpoint measurement to test against patients, and results were further compared with visual assessment results.

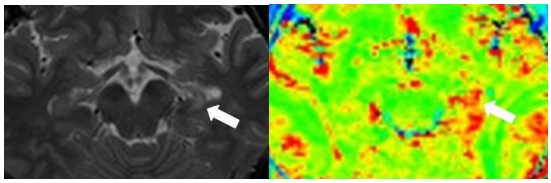

Figure1. A 37-year-old lady with left MTLE and left hippocampal sclerosis. (Left) Axial T2W image shows atrophy of left hippocampal head/ body. (Right) Corresponding T1rho parametric map reveals elevated T1rho value (red color)

Results: For the normal subjects, no statistical significant difference was observed regarding the measured T2 relaxometry and T1rho values between the left and right sides for each region. The left/right asymmetric ratios under 95% confidence intervals (mean±1.96 standard deviation) were AM: 0.996-1.028, HH: 0.978-1.037, HB: 0.992-0.022, HT: 1.003-1.030 for T2 relaxometry; and AM: 0.989-1.012, HH: 0.987-1.007, HB: 0.992-1.011, HT: 0.990-1.013 for T1rho. All 7 patients demonstrated elevated or decreased asymmetric ratios with significantly increased T2 relaxometry and T1rho values in the variable diseased regions of interest lateralizing to the side of involvement, as judged by hippocampal atrophy. Agreement between hippocampal atrophy and asymmetric ratio was high for T1rho, showing a diagnostic accuracy of 100%; whereas that for T2 relaxometry was also good, achieving a diagnostic accuracy of 84.6%. In 4 subregions of hippocampus (4 AM) in 4 patients respectively, elevated or decreased asymmetric T1rho ratios were observed concordance to the side of epileptogenic zone but with no associated atrophy or volume loss. Similarly, in 3 subregions of hippocampus (2 AM, 1 HB) in 3 patients respectively, elevated or decreased asymmetric T2 relaxometry ratios were observed concordance to the side of epileptogenic zone but with no discernible atrophy. No false negative results were identified regarding T1rho imaging while 4 false negative cases were noted on T2 relaxometry. The results for all 7 patients are summarized in Table 1. The parametric map of a representative case is also illustrated in Figure 1.

Discussion: By depiction of asymmetric elevation in T1rho value and associated asymmetric ratio along the hippocampus, it enables lateralization of epileptogenic zone with excellent diagnostic accuracy. In addition, finding of positive T1rho results but normal volumetry in 4 hippocampal subregions reflects its ability to detect early neuronal loss and molecular changes related to epilepsy. This highlights its potential utility as an early, sensitive and robust surrogate marker for identification of epileptogenic zone in epilepsy imaging, which is more sensitive than T2 relaxometry. Generation of color-coded parametric map would also be a great asset for easy visual assessment in clinical use.

Conclusion: T1rho imaging is feasible and potentially useful as a single non-invasive imaging tool in detection of the epileptogenic zone in patients with MTLE.

	Side of	Amygdala			Hippocampal Head			Hippocampal Body			Hippocampal Tail		
No	involvement	Atrophy	T2R	T1rho	Atrophy	T2R	T1rho	Atrophy	T2R	T1rho	Atrophy	T2R	T1rho
1	Right	√	√	√	√	√	√		√				
2	Left			√	√		√	√	√	√	√		√
3	Left	√		√	√	√	√	√	√	√	√	√	√
4	Left			√	√	√	√	√	√	√	√	√	√
5	Left		√	√	√	√	√	√	√	√	√		√
6	Right	√	√	√	√	√	√	√	√	√	√	√	√
7	Left		√	√	√	√	√	√	√	√	√	√	√

Table 1. Summarized results of hippocampal volumetry, T2 relaxometry & T1rho asymmetric ratios (95% confidence interval) of all 7 patients. *(√ denotes disease involvement with evidence of hippocampal atrophy or significantly asymmetric ratios)*