# THE INCREASED DETECTIVITY OF PUNCTATE WHITE MATTER LESIONS IN NEONATAL BRAINS BY USING THREE-DIMENSIONAL HIGH SPATIAL RESOLUTION T1 WEIGHTED IMAGES

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***Introduction***

Punctate white matter lesion (PWML) is a common brain injury in neonates[1]. It always presented as distinct hyperintensity on T1 weighted image (T1WI), but can be varied from hypointensity to isointensity on T2 weighted image (T2WI). Due to its relative small size (usually < 5 mm in diameter), it can be easily missed on conventional T1WI and T2WI. Hence, we queried that conventional MRI may underestimate the extent and numbers of PWML. The three-dimensional fast spoiled gradient echo (3D-FSPGR) T1WI with high spatial resolution may be more sensitive in detecting these subtle lesions. Therefore, the compared study between 3D T1WIs and other MRI sequences, including conventional T1WI, T2WI, diffusion weighted imaging (DWI), and enhanced T2* weighted angiography (ESWAN) was implemented to assess detectivity of PWML.

***Methods***

This study was approved by the local institutional review board. The neonates were all sedated (oral chloral hydrate, 25-50 mg/kg) before MRI scanning. 12 preterm neonates (gestational age (GA) 35.43±1.19 weeks, range from 32 to 36 weeks) and 25 full term neonates (GA 39.48±1.92 weeks, range from 37 to 42 weeks) who underwent 3D-FSPGR T1WI, conventional T2WI, DWI, ESWAN (enhanced T2* weighted angiography) and diagnosed as PWML were enrolled. All MR sequences were performed on a 3T scanner (Signa HDxt, General Electric Medical System, Milwaukee, WI, USA) with 8-channel head coil. The protocols of each sequence were listed as follows: (1) 3D-FSPGR T1WI: TR/TE=10/4.6ms, slice thickness=1mm, field of view =180mm×180mm, acquisition matrix=256×256, acquisition time=5 minute 10 seconds; (2) T2WI: TR/TE=4200/120ms, slice thickness=4mm without gap, field of view =180mm×180mm, acquisition matrix=256×256, echo train length =32, number of signal acquisition=1.5, number of sections=20, acquisition time=2 minute 14 seconds; (3) DWI: b value=1000s/mm2, TR/TE=5500/95ms, slice thickness=4 mm without gap, field of view=180mm×180mm, matrix=256×256; (4)ESWAN: TR/TE=51/6~60ms, number of echoes=8, FA=20°, slice thickness=2mm without gap, NEX=0.69，FOV=180mm×180mm, matrix=384×256, acquisition time = 3 minute 20 seconds. 3D-FSPGR T1WI, DWI and ESWAN data were post-processed using the multiplanar reconstruction function of a standard workstation (AW workstation, GE Healthcare) to generated reconstructed axial T1WI(thickness=4mm), apparent diffusion coeffecient (ADC), magnitude and phase maps of ESWAN. All reconstructed maps were matched with T2WI. Two pediatric neuroradiologists, who were blind to the clinical history, calculated the numbers of PWML of each neonate in all images independently. The numbers of PWML were finally determined through discussion and used in further analysis. Chi-square tests were performed to compare difference of relevance ratios between 3D-FSPGR T1WIs and other MR sequences. All tests were taken to be significant at $p<0.05$.

***Results***

The typical PWMLs in 3D-FSPGR T1WI, reconstructed T1WI, T2WI, ADC, magnitude and phase maps of ESWAN were shown in **Fig.1**. It can be found that all PWMLs observed on 3D-FSPGR T1WI would not always be detected as abnormal signal on other MRI sequence. A total of 294 lesions were detected on 3D-FSPGR T1WI, while only 158, 131, 129, 85, 34 lesions were observed on ADC, T2WI, reconstructed T1WI, magnitude and phase maps of ESWAN, respectively. The detectivity of PWML between 3D-FSPGR T1WI and other MR sequences showed significant difference (seen in **Fig.2**).The Bland-Altman plot was exhibited in **Fig.3**. The mean difference in counted numbers was -1.13 (SD =4.34), and 95% Limits of agreement was from -9.65 to 7.38, which indicated excellent agreement between the two independent observers.

***Discussion***

In current study, the punctate white matter lesions present various signal characteristics on different sequences of MRI. These lesions are seen in T1WIs as abnormal hyperintensities, in T2WIs and ADC maps as abnormal hypointensities to isointensities, in the Magnitude and phase maps of ESWAN as abnormal hyperintensities, isointensities or hypointensities[2,3]. It is easier to find the lesions with high signal on T1WI sequence than on other sequences, meanwhile some lesions in other sequences exhibiting as isointensities are easier to be missed. Moreover, some tiny PWMLs are tend to missing due to partial volume effect in other sequences.

***Conclusions***

This study first demonstrates that 3D T1WI is more sensitive in detecting PWMLs in neonatal brains relative to other MRI sequences. It is greatly recommended to use 3D T1WI as a routine sequence for neonatal brain MR examination.

***References***

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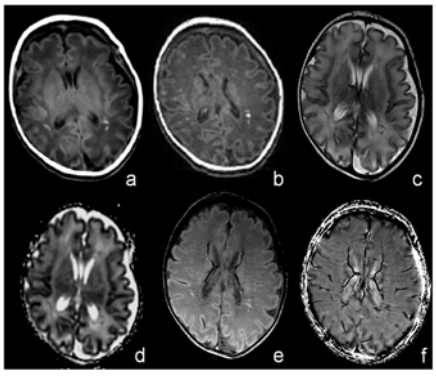


**Fig.1** Punctate white matter lesions in a neonate at PMA of 37.86 weeks. (a) 3D-FSPGR T1WI (b) T1WI (c) T2WI (d) ADC map (e) Magnitude map (f) Phase map

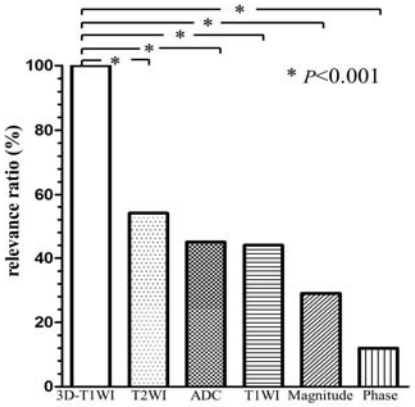


**Fig.2** Different detectivity between 3D-FSPGR T1WI and other MR sequences.

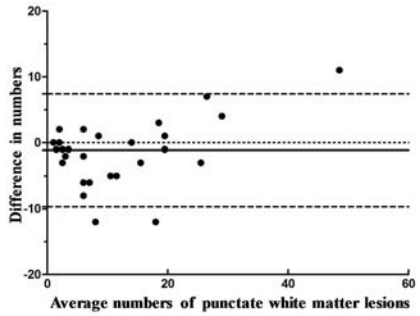


**Fig.3** Bland-Altman plot with average number for each neonate plotted against the difference in numbers between two observers for that infant. The solid line represents the mean difference in score (-1.13), and dotted lines represent 2 SD from the mean.