RADIOLOGICAL EVALUATION OF QUIET T1-WEIGHTED PETRA IN COMPARISON WITH ROUTINE BRAIN MPRAGE IN PEDIATRIC PATIENTS

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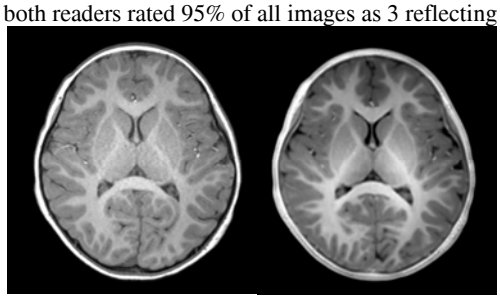
Target audience Pediatric radiologists and Neuroradiologists

Purpose High acoustic noise from conventional MRI sequences may disturb sedated pediatric patients and is one of the main reasons for patient restlessness. The PETRA sequence [1] only requires very limited gradient activity and allows for inaudible scanning. The purpose of this study was to evaluate the clinical efficacy of a prototype T1-weighted PETRA sequence [2] in pediatric patients.

Methods *Patients* In pediatric patients who underwent routine brain MRI under sedation, we tried to run T1-PETRA without applying additional sedation after routine examinations that included MPRAGE. Our IRB approved this prospective study, and written consent was obtained from parents. *MR Imaging* All studies were performed on a 3T clinical scanner (MAGNETOM Verio, Siemens, Erlangen, Germany) using a 32-channel head coil. Our routine MPRAGE and T1-weighted prototype PETRA protocols are shown in the table. The latter was adjusted to be as short as possible while maintaining sufficient spatial resolution. In the PETRA sequence, the k-space center is measured after the very first inversion pulse. Since the brains of developing infants have a longer T1 value than that of older patients, a longer first TI was used for them (measured brain T1 value x 0.7). Acoustic noise levels were measured ten times for each sequence at a distance of 2.5m from the front panel of the magnet. *Image analysis* For all images from patients who underwent complete MPRAGE and PETRA scans, two independent radiologists (a pediatric radiologist and a neuroradiologist) rated the degree of myelination in 1) anterior temporal subcortical white matter (WM), 2) cerebellar WM at the level of the inferior horn of the lateral ventricle, 3) the anterior part of the posterior internal capsule, 4) the genu and 5) the splenium of the corpus callosum, as well as in subcortical WM in 6) the posterior occipital lobe and 7) the anterior frontal lobe at the level of the foramina of Monro. A four-point scale was used: 0, low intensity; 1, iso-intensity; 2, relatively high; and 3, high-intensity compared to nearby gray matter. *Statistical analysis* For each reader, agreement of scoring for the degree of myelination between MPRAGE and PETRA was assessed by calculating intra-class correlation (ICC).

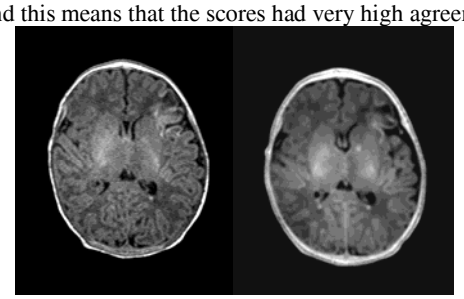
	MPRAGE			***PETRA***
orientation	Transvere	Transverse	Transverse	(Sagittal)
FOV(mm)	150	200	240	285
TI(ms)	800	800	800	700
TR(ms)	1570	1570	1570	2350
TE(ms)	2.14	2.79	2.77	0.07
echo space	5.2	5.2	5.2	3.75
slice thickness(mm)	1	1	1	0.8
FOV Phase	100%	87.50%	87.50%	100%
slice oversampling	100%	36.40%	25.00%	0%
slice per slab	128	176	192	352
flip angle(deg)	9	9	9	6
matrix	154*192	168*192	224*256	352*352
scan time	3:27	3:05	3:05	4:20

Results *Patients* Evaluable MPRAGE and T1- PETRA scans were completed in 56 children (age: 5 days-14 years, mean 36.6 months, median 25 months). *Acoustic noise* Average mean acoustic noise levels of MPRAGE and PETRA were, respectively, 34.0 dB(A) and 4.8dB(A) higher than the baseline noise level of 53.4dB(A); i.e., the noise levels without subtracting the baseline were 87.4dB(A) and 58.2dB(A). *Image and Statistical analysis* All MPRAGE and PETRA images were of sufficient quality for the radiological interpretation even though small motion artifacts existed in some images. ICC scores of the degree of myelination were 0.83 and 0.83 in each reader in the temporal subcortical WM (Single measures, n=56), 0.82 and 0.80 in the anterior part of the internal capsule (n=56), 0.87 and 0.98 in the genu (n=54, callosal dysgenesis in 2 cases), 0.85 and 0.93 in the splenium (n=53, callosal agenesis/dysgenesis in 3 cases), 0.92 and 0.93 in posterior occipital WM (n=56), and 0.92 and 0.94 in anterior frontal WM (n=56). All but one ICC value indicated excellent agreement. (ICC was undefined for cerebellar WM simply due to unevenly distributed scores; specifically, both readers rated 95% of all images as 3 reflecting matured myelination there, and this means that the scores had very high agreement).



Age 3 years

MPRAGE PETRA



A neonate with lt. MCA infarction

MPRAGE PETRA

Discussion In contrast with MPRAGE which had a noise level that was 34.8dB(A) above the background, the acoustic noise of PETRA was only 4.8 dB(A) above the background and was nearly silent. PETRA was much gentler to the sedated pediatric patients. Actually sedated children seldom woke up during PETRA sequence. Regarding image quality, ICC values for the degree of myelination in all but one area indicated excellent agreement. The results suggest that T1-weighted PETRA can be a reliable substitute for MPRAGE, though the scan time is approximately one minute longer. Although only the degree of myelination was scored in this study (due to differing effective spatial resolutions of the sequences), we believe that PETRA provides T1-weighted images that are of sufficient quality for diagnostic use, as the figures indicate.

Conclusion The prototype T1-weighted PETRA sequence produced less acoustic noise and provided good image quality by taking about one minute longer for scanning, and can be reliably substituted for MPRAGE in order to provide gentler scans to pediatric patients..

References [1]Grodzki et al. MRM 2012;67:510-18 [2] Grodzki et al Proc. ISMRM 2013