
Feasibility of 1-minute Ultrafast Brain MRI protocol for the Pediatric Neuroimaging: a Single Center Pilot Study

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Background

▶ Fast MR imaging techniques

- ▶ Rapid non-sedated MRI evaluation of acute intracranial hemorrhage in pediatric head trauma; **SS-FSE or HASTE with GRE (2-3 min)**

Neuroradiology. 2016 Aug;58(8):793-9

- ▶ Ultrafast Brain MRI: Clinical Deployment and Comparison to Conventional Brain MRI at 3T; **adult group, full brain sequence (5 min)**

J Neuroimaging. 2016 Sep;26(5):503-10

- ▶ 1-min ultrafast full brain MRI compared with synthetic MRI; adult group, full brain sequence; **adult group, full brain sequence (1 min)**

J Neurology, 2019 Feb;266(2):431-439



Objective

- ▶ This study investigated the clinical feasibility of a **1-minute ultrafast brain MRI protocol** by evaluating **image quality assessment** in the **pediatric patients.**



Materials and Methods

- ▶ **Retrospective study**
- ▶ From **November 2018** and **March 2019**
- ▶ **Inclusion criteria**
 - ▶ Pediatric patients (younger than 18 years)
 - ▶ Consecutive patients who underwent both ultrafast sequences and corresponding routine protocols in our institution



Materials and Methods

▶ Imaging acquisition

- ▶ 3T system (Signa™, Architect; GE Healthcare, Milwaukee, Wisconsin)
- ▶ 48/16 channel head coil
- ▶ Both ultrafast and routine MRI protocols
 - ▶ axial T1WI
 - ▶ axial T2WI
 - ▶ axial FLAIR
 - ▶ DWI
 - ▶ SWAN/T2*-weighted images (T2*WI)



► Representative Imaging protocol

Parameter	Routine MRI					Ultrafast MRI				
	T1WI	T2WI	FLAIR	DWI	SWAN	T1WI	T2WI	EPI-FLAIR	DWI	T2*WI
FOV (mm)	180	180	180	180	180	240	240	240	240	240
Thickness (mm)	4	4	4	4	2.4	4	4	4	4	4
TR (ms)	230	4631	9000	6018	34.6	185.1	429.4	10000	2778	1600
TI (ms)			2465					2200		
TE (ms)	3.1	100	102.4	73.6	23.4	2.8	102	100	69.2	20.7
ETL		18	32							
Frequency matrix	300	320	288	128	288	260	320	128	128	128
Phase matrix	288	320	288	192	260	190	320	256	128	320
Flip angle (°)	90	90	90	90	15	60	90	90	90	25
Bandwidth (kHz)	27.78	62.50	41.67	250	41.67	31.25	83.33	250	250	250
Parallel imaging acceleration factor			ARC3	ASSET2 .5	ASSET2	ARC2	ASSET3		ARC2	ASSET2
Net scan time (min:s)	1:08	2:38	2:25	1:36	1:44	0:17	0:09	0:25	0:14	0:06
Total scan time (min:s)			9:51					1:11		

► ARC autocalibrating reconstruction for Cartesian imaging, ASSET array spatial sensitivity

Materials and Methods

▶ Radiologic assessment

- ▶ 2 radiologists (2-years pediatric radiologist and 3-years neuroradiologist)

Sequences	Criteria assessed	Four-point assessment scale
T1 T2 FLAIR	(1) Overall image quality (2) Differentiation of gray-white matter at the level of the lateral ventricles (3) Demarcation of basal ganglia (4) Demarcation of sulci	(1) Inadequate (not acceptable for diagnostic use) (2) Sufficient (acceptable for diagnostic use but with minor issues) (3) Good (acceptable for diagnostic use) (4) Excellent (acceptable for diagnostic use)
	(5) Motion artifact	(1) Severe artifacts (not acceptable for diagnostic use) (2) Moderate artifacts (sufficient for diagnostic use with minor issues) (3) Mild artifacts (acceptable for diagnostic use) (4) No visible artifacts (acceptable for diagnostic use)
DWI SWAN and Ultrafast T2*	(1) Overall image quality	(1) Inadequate (2) Sufficient (3) Good (4) Excellent
	(2) Susceptibility artifact (3) Motion artifact	(1) Severe artifacts (2) Moderate artifacts (3) Mild artifacts (4) No visible artifacts

Materials and Methods

▶ Statistical Analysis

- ▶ SPSS statistics 24
- ▶ The Wilcoxon signed-rank test; to compare the reader's consensus ratings of routine and ultrafast MRI protocols
- ▶ Interobserver reliability between two readers; percent agreement




Results

▶ **Total 23 pediatric patients**

- ▶ 12 boys and 11 girls
 - ▶ mean age; 9.5 years \pm 6.3 , range; 2 days – 17 years

▶ **Reason of MRI examination**

- ▶ Headache (10/23, 44 %)
 - ▶ Congenital anomaly work-up (4/23, 17 %)
 - ▶ Syncope (3/23, 13 %)
 - ▶ Follow-up for arachnoid cyst (2/23, 9 %)
 - ▶ Term equivalent MRI for preterm infants (2/23, 9 %)
 - ▶ Seizure (1/23, 4 %)
 - ▶ Cyclic vomiting syndrome (1/23, 4 %).
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Results

Assesment of routine and ultrafast MR image using a four-point assessment scale

	Routine MRI				Ultrafast MRI				P value
	R1	R2	Mean	Agreement (%)	R1	R2	Mean	Agreement (%)	
T1									
STN	3.8±0.3	3.9±0.3	3.9±0.4	20/23 (87)	3.0±0.4	3.0±0.0	3.0±0.2	19/23 (83)	< 0.001
GM-WM	4.0±0.2	4.0±0.2	4.0±0.2	23/23 (100)	3.0±0.4	3.4±0.4	3.2±0.5	14/23 (61)	< 0.001
BG	3.9±0.4	4.0±0.2	3.9±0.3	21/23 (91)	3.3±0.4	3.2±0.4	3.3±0.4	21/23 (91)	< 0.001
Sulci	4.0±0.0	4.0±0.2	4.0±0.1	22/23 (96)	3.5±0.5	3.8±0.4	3.6±0.4	16/23 (70)	< 0.001
Motion	3.2±0.4	3.2±0.6	3.2±0.5	15/23 (65)	3.1±0.5	3.0±0.3	3.0±0.4	19/23 (83)	0.059
T2									
STN	3.9±0.3	4.0±0.0	3.9±0.2	20/23 (87)	3.3±0.4	3.2±0.4	3.3±0.4	21/23 (91)	< 0.001
GM-WM	3.9±0.2	4.0±0.0	4.0±0.2	21/23 (91)	3.7±0.4	3.4±0.5	3.6±0.4	16/23 (70)	< 0.001
BG	3.9±0.2	4.0±0.0	4.0±0.2	21/23 (91)	3.4±0.5	3.4±0.5	3.4±0.5	15/23 (65)	< 0.001
Sulci	4.0±0.0	4.0±0.0	4.0±0.0	23/23 (100)	4.0±0.0	4.0±0.0	4.0±0.0	23/23 (100)	1.00
Motion	3.8±0.4	3.9±0.2	3.8±0.3	18/23 (78)	3.9±0.2	3.9±0.3	3.9±0.3	18/23 (78)	0.480
FLAIR									
STN	3.8±0.3	4.0±0.0	3.9±0.2	19/23 (83)	2.5±0.5	2.1±0.3	2.3±0.4	14/23 (61)	< 0.001
GM-WM	3.9±0.2	4.0±0.0	4.0±0.2	21/23 (91)	1.8±0.4	1.9±0.2	1.9±0.3	17/23 (74)	< 0.001
BG	3.8±0.4	4.0±0.0	3.9±0.3	18/23 (78)	3.3±0.9	3.5±0.8	3.4±0.8	18/23 (78)	< 0.001
Sulci	4.0±0.0	4.0±0.0	4.0±0.0	23/23 (100)	3.1±0.2	3.0±0.2	3.1±0.2	22/23 (96)	< 0.001
Motion	3.6±0.5	3.6±0.4	3.6±0.5	15/23 (65)	3.8±0.4	4.0±0.0	3.9±0.3	20/23 (87)	< 0.001

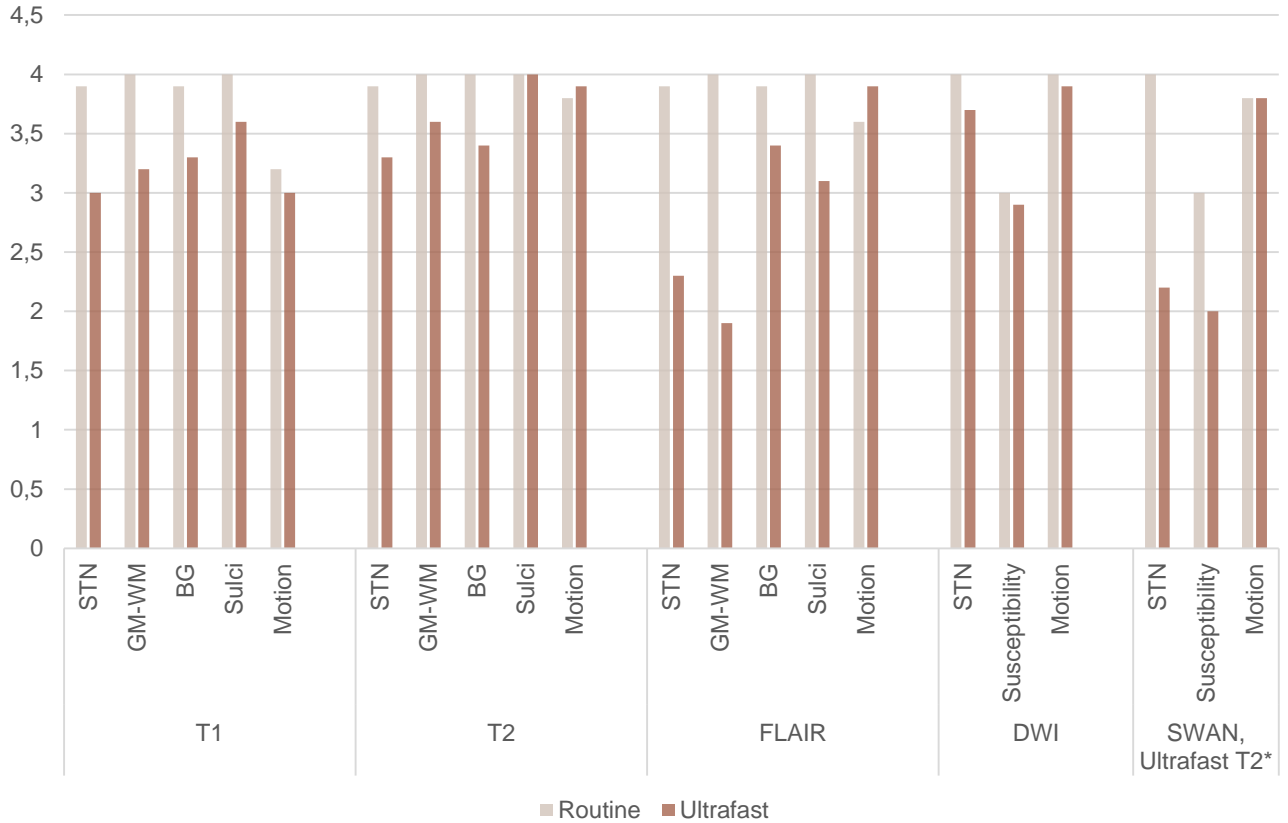
Results

► **Assesment of routine and ultrafast MR image using a four-point assessment scale**

	Routine MRI				Ultrafast MRI				P value
	R1	R2	Mean	Agreement (%)	R1	R2	Mean	Agreement (%)	
DWI									
STN	3.9±0.2	4.0±0.0	4.0±0.2	21/23 (91)	3.7±0.5	3.8±0.4	3.7±0.5	19/23 (83)	0.029
Susceptibility	3.1±0.4	3.0±0.0	3.0±0.3	19/23 (83)	2.8±0.3	3.0±0.0	2.9±0.2	19/23 (83)	0.014
Motion	3.9±0.4	4.0±0.0	4.0±0.3	22/23 (96)	3.8±0.3	4.0±0.0	3.9±0.2	19/23 (83)	0.480
SWAN, Ultrafast T2*									
STN	4.0±0.0	4.0±0.2	4.0±0.1	22/23 (96)	2.1±0.3	2.2±0.4	2.2±0.3	17/23 (74)	< 0.001
Susceptibility	3.0±0.0	3.0±0.0	3.0±0.0	23/23 (100)	1.9±0.2	2.0±0.0	2.0±0.2	21/23 (91)	< 0.001
Motion	3.8±0.4	3.9±0.4	3.8±0.4	17/23 (74)	3.7±0.5	3.8±0.4	3.8±0.5	17/23 (74)	0.480

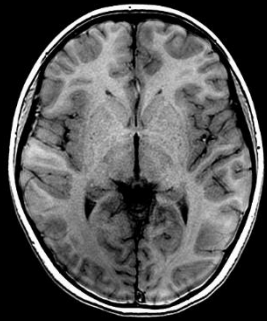


Results

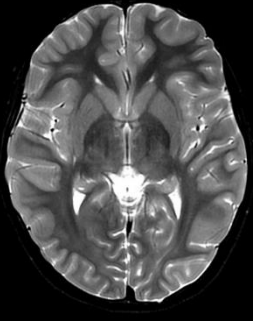


10y/F, Cyclic vomiting syndrome

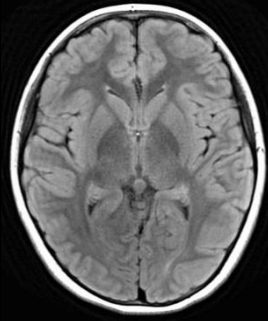
Routine T1



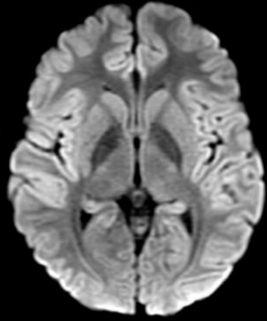
Routine T2



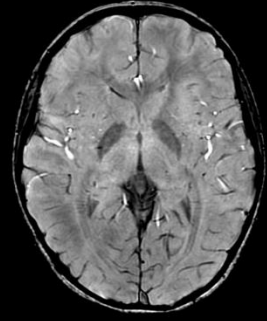
FLAIR



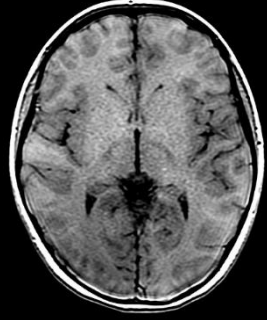
DWI



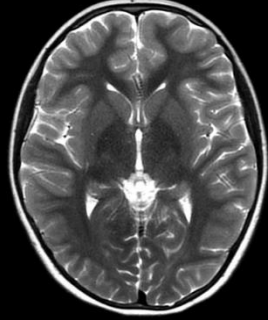
SWAN



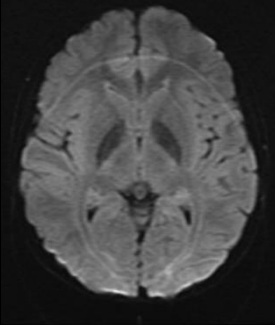
Ultrafast T1



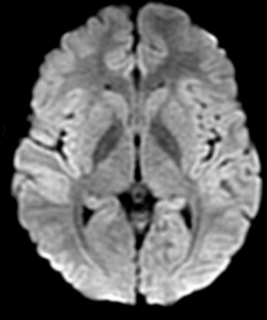
Ultrafast T2



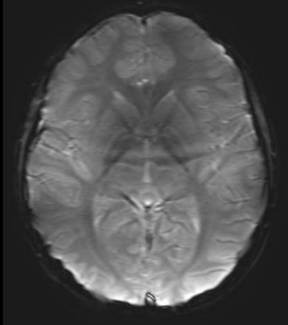
EPI-FLAIR



Ultrafast DWI

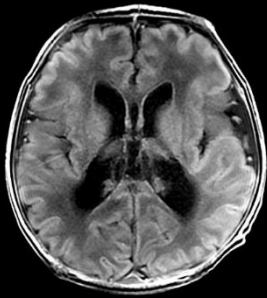


Ultrafast T2*

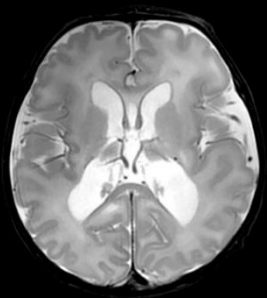


2d/F, Dandy-walker variant

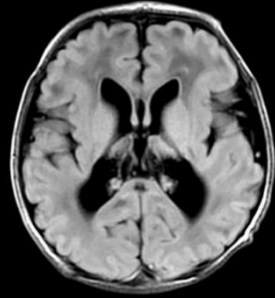
Routine T1



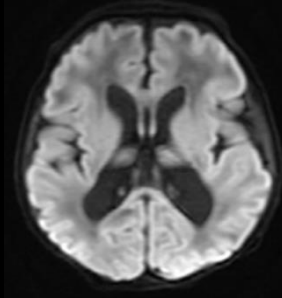
Routine T2



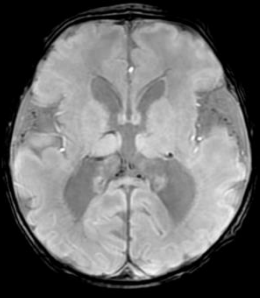
FLAIR



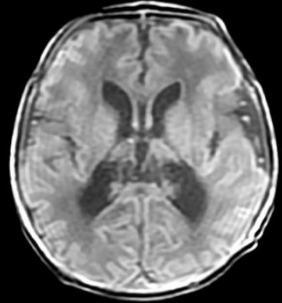
DWI



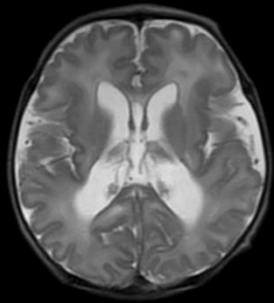
SWAN



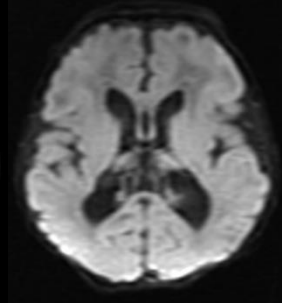
Ultrafast T1



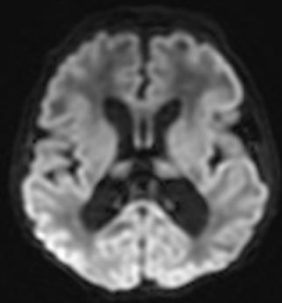
Ultrafast T2



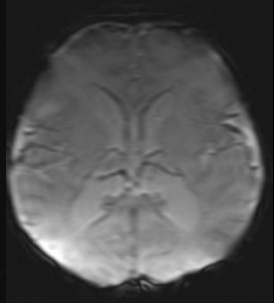
EPI-FLAIR



Ultrafast DWI

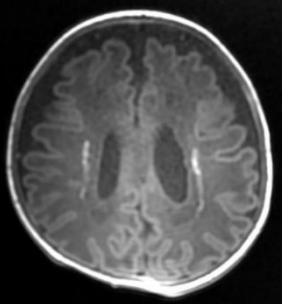


Ultrafast T2*

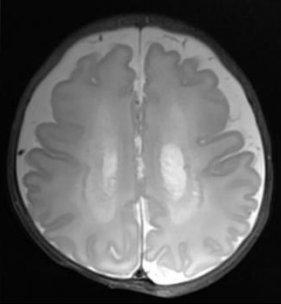


60d/F, GA 28wks, Periventricular leukomalacia

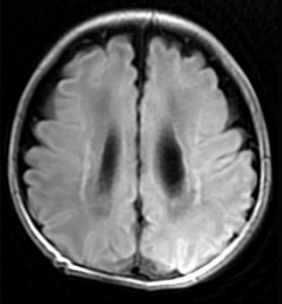
Routine T1



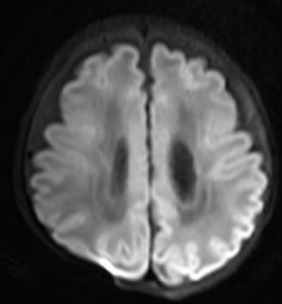
Routine T2



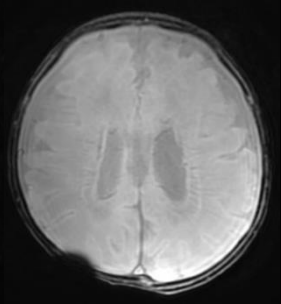
FLAIR



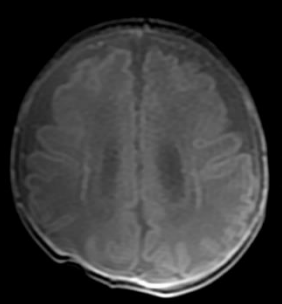
DWI



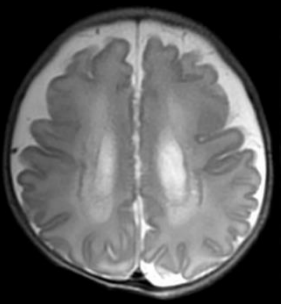
SWAN



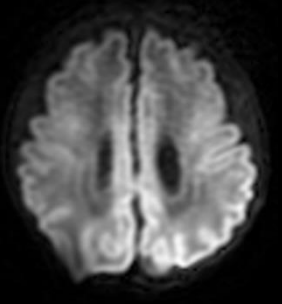
Ultrafast T1



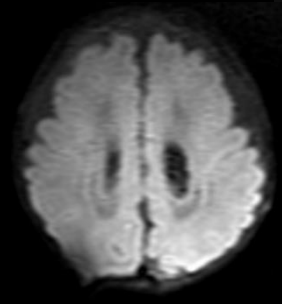
Ultrafast T2



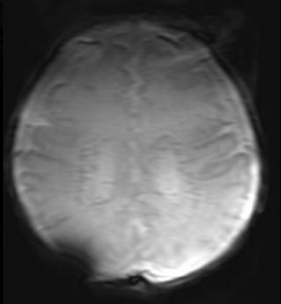
EPI-FLAIR



Ultrafast DWI



Ultrafast T2*



Conclusion

- ▶ Therefore, this 1-min ultrafast protocol may be an option in specific clinical situations in the pediatric patients unable to tolerate longer scan time.
- ▶ We expect the reduce of the need for sedatives during examination.
- ▶ Further technological advances to improve the overall quality are required to expand the clinical use.
- ▶ Further studies with larger sample sizes and various MR scanners are essential to validate our results.



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19th Annual Scientific Meeting of Asian and Oceanic Society for Paediatric Radiology

**September
26 - 28, 2019**

**Seoul Dragon City
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Deadlines

Abstract Submission: **April 30, 2019**

Pre-registration: **June 30, 2019**

Travel Grant

AOSPR 2019 has a travel grant program to encourage participation from overseas. The recipient will be selected from those who submit abstract(s).

