

# Case Series: Pediatric<sup>1</sup> GOBrain-5-Minute Protocol MR Imaging at 3 Tesla

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## Background

Fast-brain MRI was first introduced for children<sup>1</sup> with shunt dependent hydrocephalus<sup>2-3</sup> who frequently undertake serial imaging studies through life. The image studies often include a combination of both CT and MRI depending on the child's age, study time, and availability of equipment. CT scans involve exposure to radiation, which has potentially harmful effects, especially for young children<sup>4</sup>. The alternative to a CT scan is MRI, but brain MRI is time consuming and sensitive to motion artifacts. In young patients, MRI studies might require sedation or general anesthesia, which have their own risks of complications<sup>5</sup>. Therefore, fast MRI sequences can avoid the need for sedation or anesthesia, and are thus particularly useful for young and uncooperative patients. Recently, fast MRI sequences have become more popular and these are increasingly being used for non-hydrocephalic indications such as macrocephaly, intracranial cysts, screening for some structural congenital and non-congenital anomalies, and postoperative follow-up<sup>6</sup>.

A number of 'fast MRI' protocols have been used; the most popular are modifications of T2-weighted MRI, including Half-Fourier Acquisition Single-shot Turbo Spin Echo (HASTE)<sup>7</sup>, Single Shot Fast Spin Echo (SSFSE)<sup>6,8</sup>, and Periodically Rotated Overlapping Parallel lines with enhanced reconstruction (PROP) FSE<sup>2</sup>. These protocols often use a single type of pulse sequence which carries potential pitfalls. Our previous study<sup>9</sup> demonstrated undetected findings in 7/50 (14%) pediatric fast brain MRI including venous sinus thrombosis (one patient), subdural hematoma (three), failure to differentiate blood products (two), and limited evaluation of extra-axial collections (one). This limitation was seen to be due to the lack of other pulse sequences to further characterize tissue and fluid. Consequently, there is a known need to improve image quality using fast MR protocols for all clinically relevant sequences; this is likely to occur when different pulse sequences and planes are used for evaluation of the brain tissues and fluids.

GOBrain<sup>10,11</sup> was developed as a 5-minute diagnostic brain exam and was clinically validated to be diagnostically equivalent to the longer, conventional exam. The 5-minute examination provides the basic clinical sequences including sagittal T1-weighted, axial T2-weighted, axial T2 TSE Dark Fluid (FLAIR), axial diffusion-weighted (DWI), and axial T2\*-weighted sequences. Several factors, like parallel imaging with higher acceleration factors, gradient T1-weighted and EPI-GRE T2\*-weighted acquisitions, have

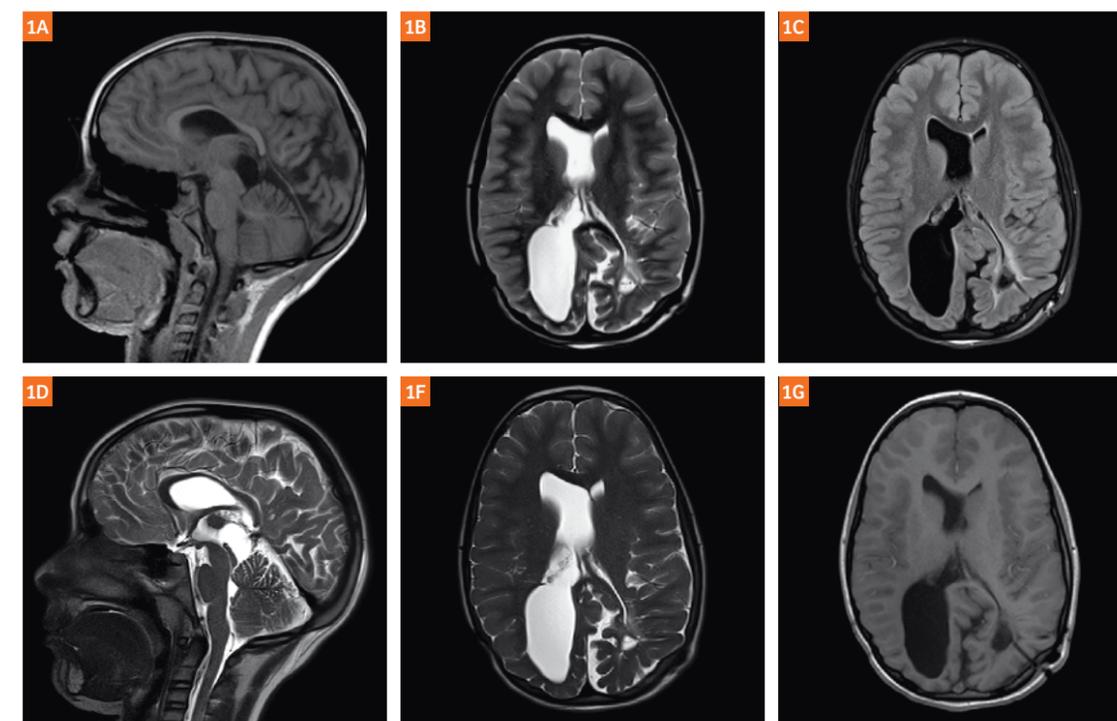
made it possible to shorten the scan time but have also alleviated EPI-related susceptibility artifacts and image distortions by reducing the EPI-factors and shortened the inter-echo spacing. The hope is that the 5-minute protocol will reach high diagnostic concordance for the diagnosis of clinically relevant findings compared to the conventional protocol, and therefore become useful in a selected group of pediatric patients that are more prone to motion and the need for anesthesia.

**Table 1:** Acquisition parameters and scan time for 5-minute GOBrain MRI protocols on the MAGNETOM Skyra with the Head/Neck 20 coil.

	Plane	TR (ms)	TE (ms)	FOV (mm)	Phase FOV (%)	Slices	Slice (mm)	Gap (%)	Matrix	Phase directions	iPAT factor	b-values	Directions (no)	TA (mins)
AutoAlign Head Scout	3D	3.15	1.37	260	100	128	1.6	20	160	A-P	3	NA	NA	0:14
T1 GRE FLASH	Sag	240	2.46	220	100	35	4.0	20	256	A-P	2	NA	NA	0:41
T2 TSE	Axial	6200	78	220	87.5	25	5.0	20	256	R-L	3	NA	NA	1:02
T2 TSE DarkFluid	Axial	8000	119	220	87.5	25	5.0	20	256	R-L	2	NA	NA	1:52
ep2d Diffusion	Axial	4200	72	240	100	31	5.0	12	160	A-P	2	0,800	12	1:16
ep2d T2*W	Axial	6120	30	220	100	25	5.0	20	128	A-P	1	NA	NA	0:06
<b>Total exam time</b>														5:11

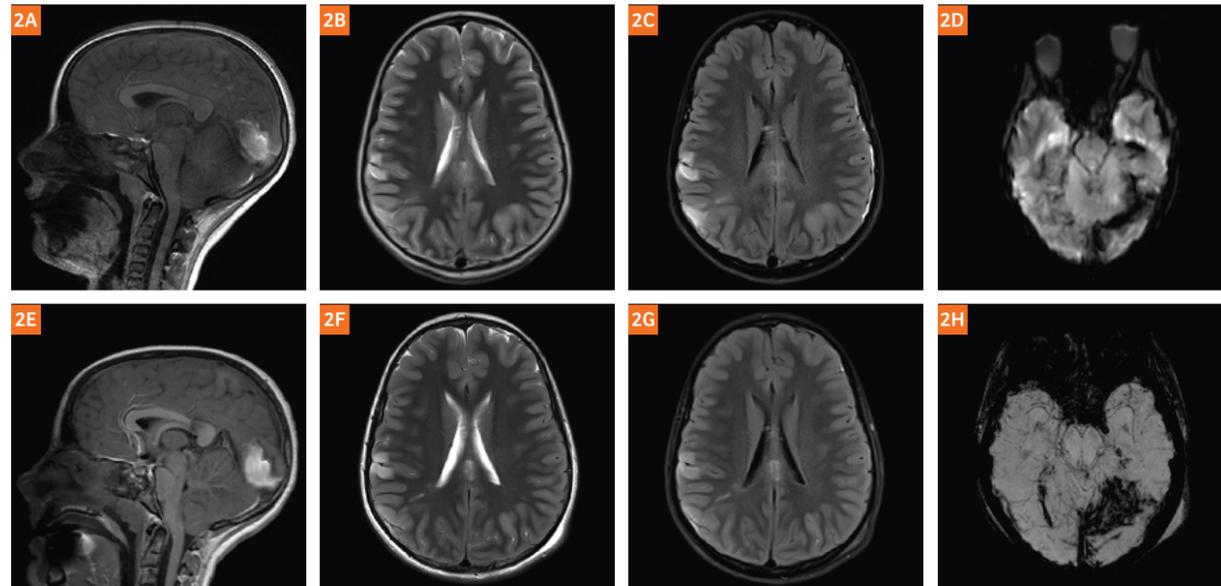
<sup>1</sup>MR scanning has not been established as safe for imaging fetuses and infants less than two years of age. The responsible physician must evaluate the benefits of the MR examination compared to those of other imaging procedures.

## Case 1



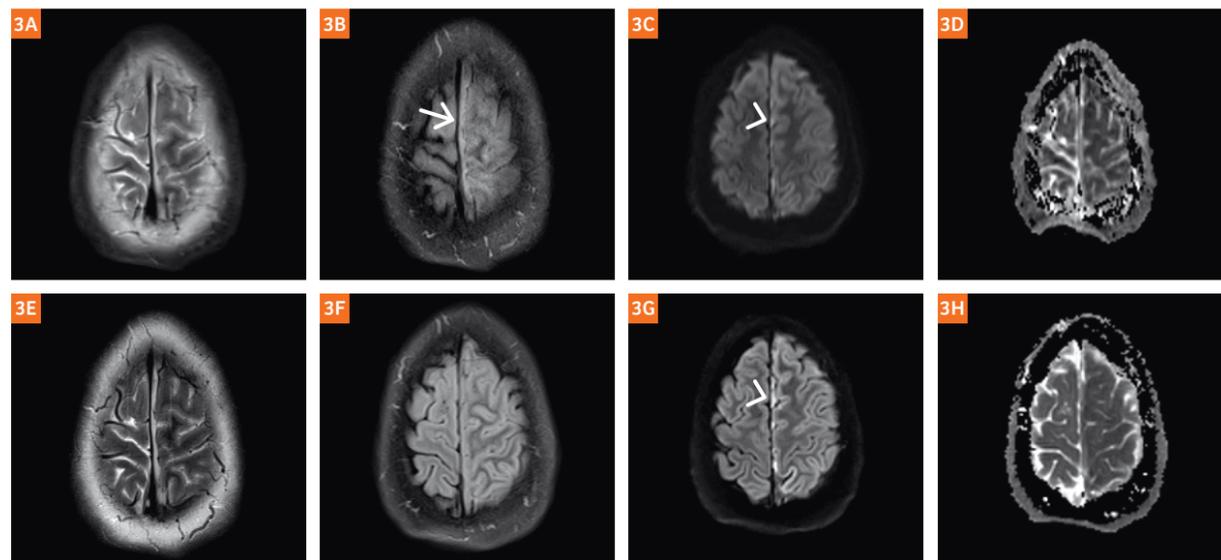
**1** 9-year-old female, congenital hydrocephaly with multiple shunt revisions. Top row GOBrain (1A–C: Sagittal T1w, axial T2 TSE, axial T2 TSE FLAIR). Bottom row, conventional fast sequences (1D–F: Sagittal T2w, axial T2 HASTE, axial T1 FLASH 2D). No interval change in the asymmetric size of the ventricular system or position of the shunt catheter (arrow). The studies are comparable, adding a T2 FLAIR (1G) sequence has the potential to further characterize fluid and brain findings.

**Case 2**



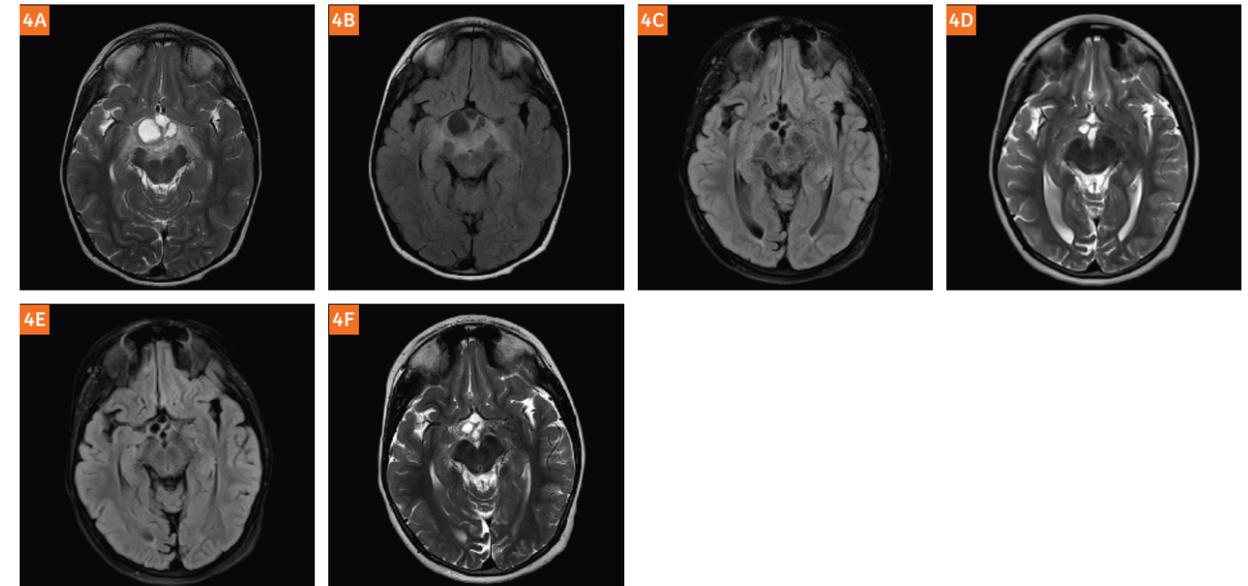
**2** 10-year-old female with severe traumatic brain injury. Top row GOBrain (2A–D: Sagittal T1w, axial T2 TSE, axial T2 FSE FLAIR, and axial T2\*) obtained 3 days after the conventional MRI. Bottom row, routine sequences (2E–H: Sagittal T1w, axial T2w, axial FLAIR, and susceptibility-weighted imaging (SWI)). Findings consistent with brain contusion in the posterior parieto-occipital cerebral hemispheres and subdural bleed along the left tentorium (arrow). There is comparable conspicuity of the contusion and blood products with the routine and the GOBrain-5-minute protocol.

**Case 3**



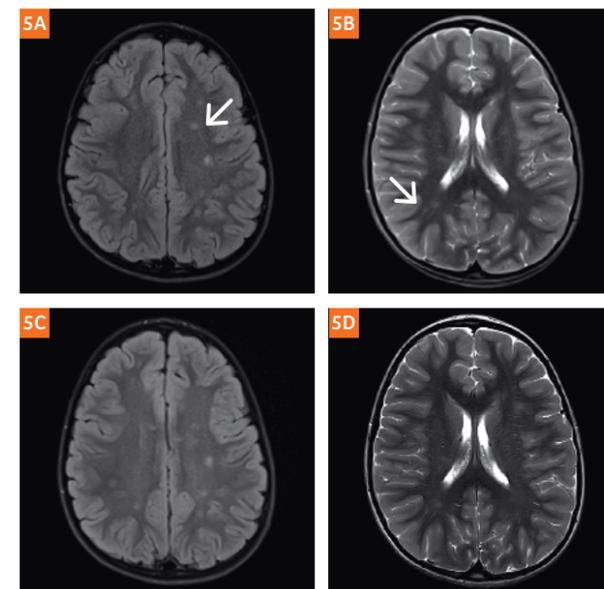
**3** 14-year-old male, complicated left frontal sinusitis with a left parasagittal extra-axial collection (arrow) resulting in meningitis. Top row GOBrain (3A–D: axial T2 TSE, axial T2 TSE FLAIR, axial DWI, and axial ADC) obtained the same day as conventional MRI. Bottom row, routine sequences (3E–H: axial T2w, axial FLAIR, axial DWI, and axial ADC). Diffusion restriction was appreciated in the left frontal sinus (not shown), in the left parasagittal collection (arrowhead). The cortical sulci in the left frontal and parietal lobe demonstrate mild effacement. The images exemplify the comparable image quality in the GOBrain-5-minute protocol (top row), compared to the conventional protocol (bottom row).

**Case 4**



**4** 7-year-old female, suprasellar germinoma treated with chemotherapy and radiation. 4A, B: baseline images before treatment. Top row GOBrain (4C, D: axial T2 TSE, and axial T2 TSE FLAIR). Bottom row, routine sequences (4E, F: axial T2w, and axial FLAIR) follow-up 2 years after treatment. The follow-up images exemplify the comparable image quality of the suprasellar residual lesion in the GOBrain-5-minute protocol (top row), compared to the conventional protocol (bottom row). Follow-up images using GOBrain and conventional protocols were obtained the same day.

**Case 5**



**5** 10-year-old male, 2 week history of morning headaches, waking up at night. History of anxiety. Suspected radiological isolated demyelinating type lesions. Top row GOBrain (5A, B: axial T2 TSE, and axial T2 TSE FLAIR). Bottom row, conventional sequences (5C, D: axial T2w, and axial FLAIR). The images exemplify the same number and size of white matter lesions (arrows) in the GOBrain-5-minute protocol (top row), compared to the conventional protocol (bottom row).

## Materials and methods

All images in this case series were acquired on a 3T MAGNETOM Skyra scanner (Siemens Healthineers, Erlangen, Germany). The MRI protocol typically included the routine scan as per the radiologist's request and the additional GOBrain-5-minute sequence appended to the end of the examination (Table 1).

## Conclusion

Pediatric fast imaging techniques can shorten scan times, decrease motion-related artifacts, and more importantly in children, has been shown to reduce the need for sedation<sup>1</sup>. In addition, they have the potential to reach diagnostic concordance of clinically relevant findings compared to the conventional protocol and therefore become useful in a selected group of pediatric patients that are more prone for motion and need of anesthesia. Improved patient throughput which decreases wait time can also be an advantage of this protocol.

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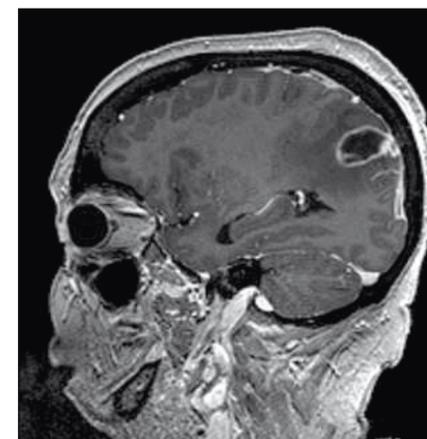
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Heightened attention to healthcare costs and value based outcomes in medicine are driving revolutionary changes in the MR industry. Siemens MR and Massachusetts General Hospital (MGH) in Boston collaborate on strategies to develop fast and clinically validated examinations in MR.

GOBrain is a diagnostic brain exam which takes 5 minutes<sup>1</sup>. It consists of five diagnostically-important MR brain protocols acquired with optimized pulse sequences. Integrated with individual anatomical landmark-based AutoAlign technology providing automatic slice positioning, this push-button exam requires minimal interaction from the technologist. The included sequences are a sagittal T1-weighted, axial T2-weighted, axial T2-weighted DarkFluid, axial diffusion-weighted and an axial T2\*-weighted contrast.

GOBrain+ expands GOBrain to additionally support brain imaging with contrast medium. New optimized sequences include an axial T1-weighted sequence administered pre- and post-contrast and a post-contrast MPRAGE.



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<sup>1</sup>Achieved on a MAGNETOM Skyra with the Head 32 coil. Total examination time can take up to 6 minutes depending on system field strength and coil density.