Pediatric brain tumor assessment using MAGiC

By Hernan Chaves, MD, and Maria Mercedes Serra, MD, staff radiologists,
Foundation for the Fight against Neurological Diseases of Children (FLENI), Buenos Aires, Argentina

Discovery™ MR750

Brain tumor MR protocol without MAGiC		Brain tumor MR protocol with MAGiC	
Sequence	*Scan time (min)*	*Sequence*	*Scan time (min)*
Sagittal T1	1:58	MAGiC	5:12
Axial T1 FLAIR	1:55		
Axial T2 PROPELLER	1:48		
T2 FLAIR	4:58		
SWAN	2:37	SWAN	2:37
DWI	1:09	DWI	1:09
FSPGR	4:40	FSPGR	4:40
Total time	**19:05**	**Total time**	**13:38**

Table 1. Comparison times between brain tumor MR protocols without and with MAGiC.

Introduction

It is often difficult for adolescent and pediatric patients to undergo a typical 20- to 40-minute neuro MR exam, especially taking into account their emotional state and health condition that requires an imaging study. As a result, pediatric patients have a difficult time complying with a technologist's request to remain still and usually end up moving during an examination. This often leads to the use of anesthesia or sedation to conduct the MR exam.

Techniques such as MAGnetic resonance image Compilation (MAGiC) may allow clinicians to shorten examination time for these patients, which can increase patient comfort and reduce potential motion artifacts without losing image quality.[1]

Patient history

A 14-year-old patient with a history of drug-resistant epilepsy. Previous CT showed a frontal space occupying lesion. They were referred to our institution for a brain MR with and without contrast to better characterize this finding.

MR technique

Our conventional MR protocol for brain tumors was performed on a Discovery™ MR750 3.0T scanner with a 32-channel Brain Coil. We included Sagittal T1 FLAIR, Axial T1 FLAIR, T2 PROPELLER, T2 FLAIR, DWI, SWAN and FSPGR after intravenous injection of gadolinium. We additionally acquired pre-contrast Axial MAGiC with 3 mm slice thickness. Comparison scan times for the brain tumor MR protocols with and without MAGiC are shown in Table 1.

Hernan Chaves, MD

Foundation for the Fight against Neurological Diseases of Children (FLENI) in Buenos Aires, Argentina

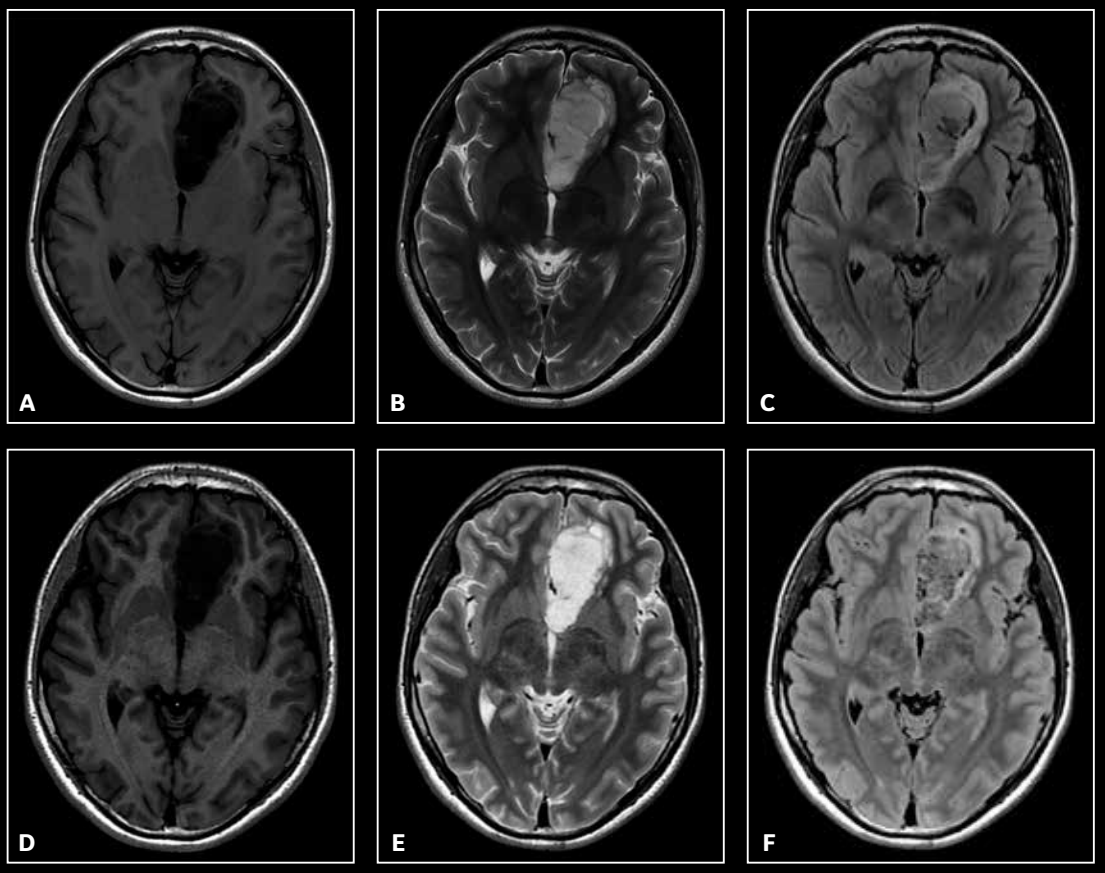

Figure 1. (A) Conventional T1, (B) T2 and (C) FLAIR sequences. (D) MAGiC T1, (E) T2 and (F) FLAIR sequences.

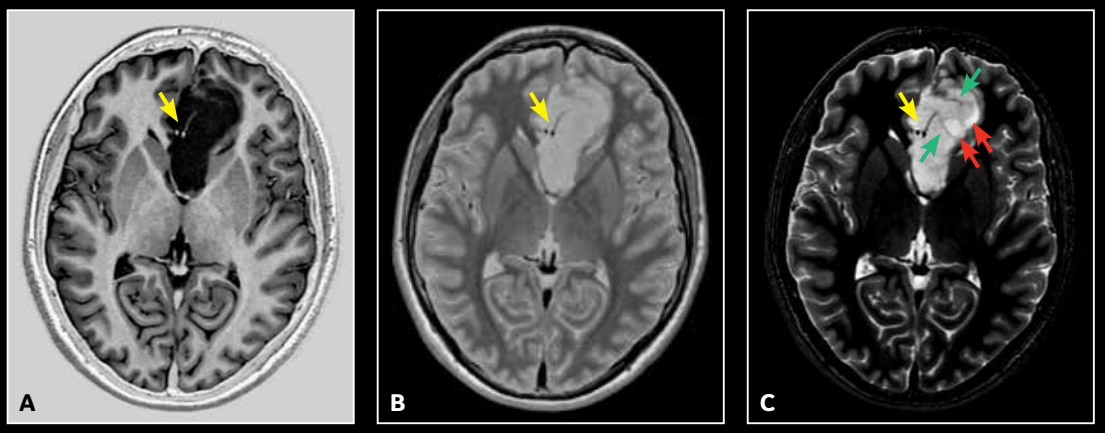

Figure 2. Additional sequences reconstructed from MAGiC. (A) PSIR, (B) PD and (C) STIR. Some tumor features can be better depicted with these sequences, including vascular encasement (yellow arrows), intratumoral cysts (red arrows) and septa (green arrows).

Maria Mercedes Serra, MD

Foundation for the Fight against Neurological Diseases of Children (FLENI), Buenos Aires, Argentina

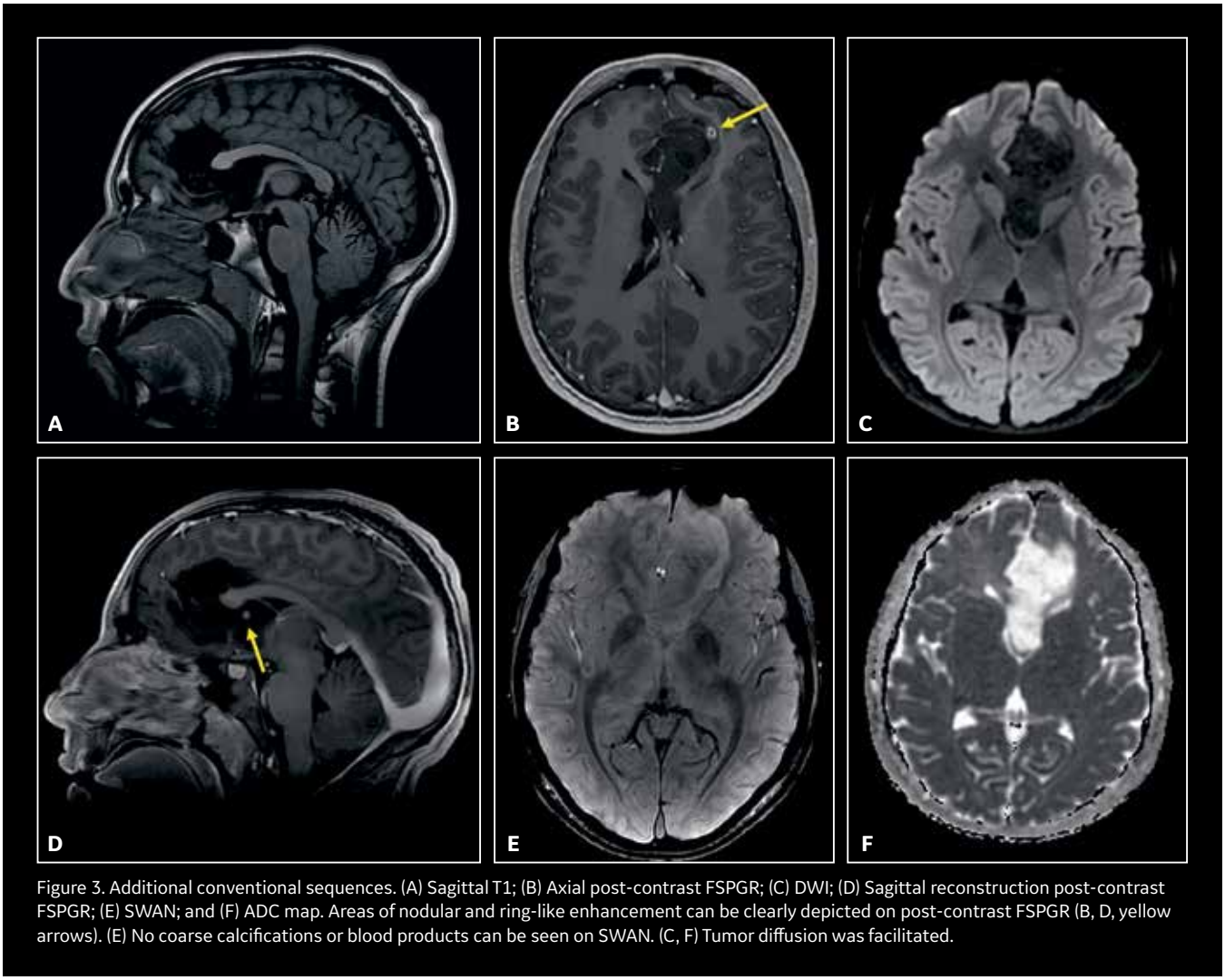

Figure 3. Additional conventional sequences. (A) Sagittal T1; (B) Axial post-contrast FSPGR; (C) DWI; (D) Sagittal reconstruction post-contrast FSPGR; (E) SWAN; and (F) ADC map. Areas of nodular and ring-like enhancement can be clearly depicted on post-contrast FSPGR (B, D, yellow arrows). (E) No coarse calcifications or blood products can be seen on SWAN. (C, F) Tumor diffusion was facilitated.

MR findings

A cortical expansive lesion was identified in the left mesial frontal region. It presented with markedly increased signal on T2-weighted and decreased signal on T1-weighted images with a bubbly appearance in both the synthetic and conventional images. On the synthetic FLAIR and STIR images, internal septations and multi-microcysts were observed with better definition (Figures 1 and 2) than on the conventional images. diffusion-weighted imaging (DWI) was facilitated within the lesion and no coarse calcifications or blood products were identified on SWAN. After intravenous contrast administration, isolated nodules and rings of enhancement were identified within the lesion. These features suggested the diagnosis of Dysembryoplastic Neuroepithelial Tumor (DNET), which was pathologically confirmed after surgery.

Discussion

MR scan duration in adolescents and pediatrics is a primary concern due to the difficulty in compliance with these patients and the desire to avoid or minimize sedation. Even when optimized, simple brain protocols will usually require at least 20 minutes to complete the study. By replacing conventional techniques with synthetic images, such as those processed with MAGiC, we could reduce the total exam time while maintaining image quality with similar diagnostic utility. Specifically, MAGiC could replace Axial T1-weighted, T2-weighted and T2 FLAIR acquisitions and can be acquired in any plane if desired. Additional sequences reconstructed from MAGiC, such as Phase Sensitive Inversion Recovery (PSIR), double IR, Proton Density (PD) and Short Tau Inversion Recovery (STIR), which are not typically acquired on conventional brain tumor protocols, could provide additional information for further analysis of MR acquisition data. PSIR is a phase sensitive reconstruction

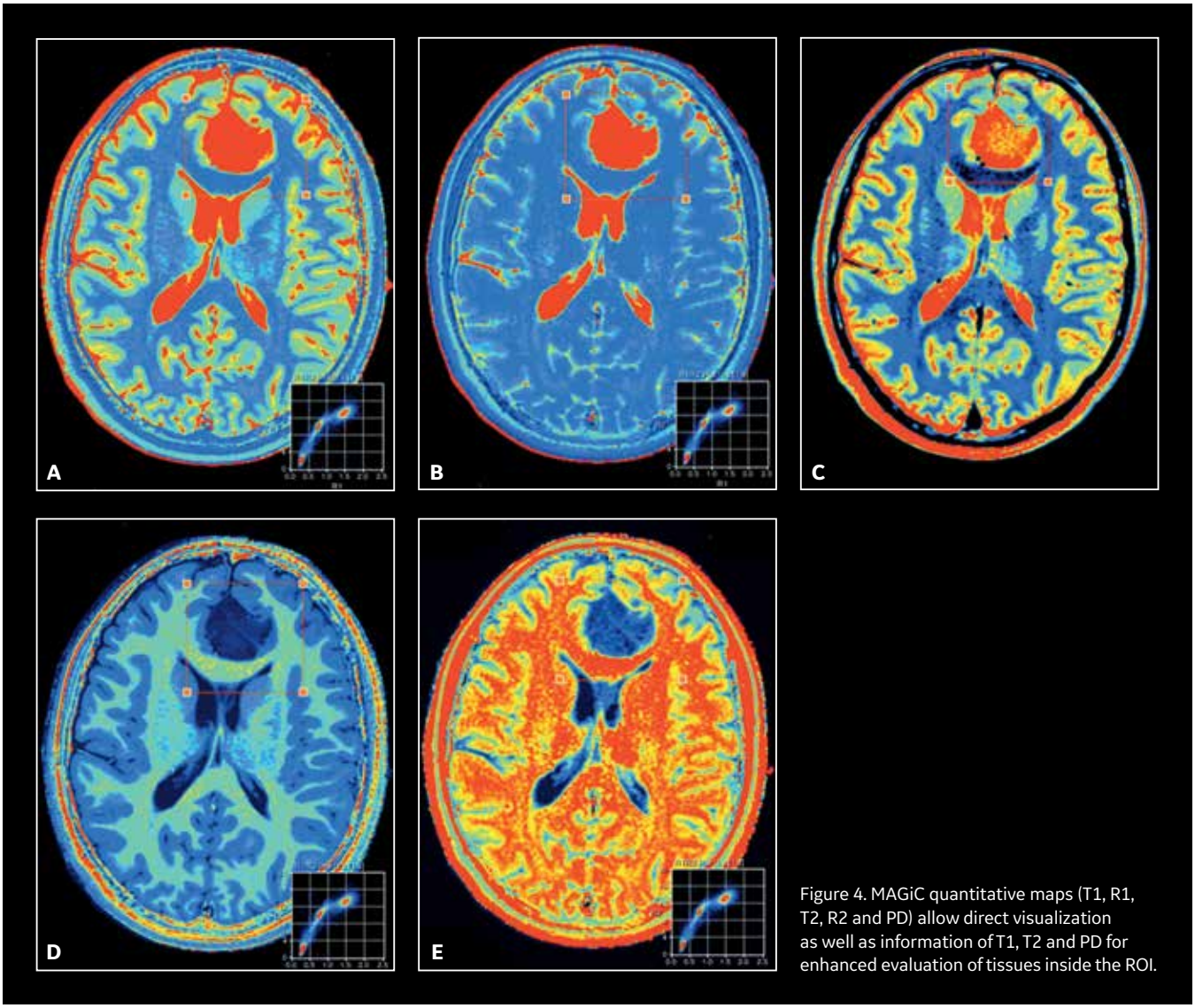

Figure 4. MAGiC quantitative maps (T1, R1, T2, R2 and PD) allow direct visualization as well as information of T1, T2 and PD for enhanced evaluation of tissues inside the ROI.

that greatly improves T1 contrast as it displays both negative and positive longitudinal magnetization amplitudes rather than normal magnitude reconstruction. In our case, we also used MAGiC T1 with a 100 ms TR and a 5 ms TE, improving contrast of normal T1 FSE.

The MR workstation enables immediate and automatic reconstruction of all MAGiC-derived series, which can then be sent to PACS for reading. For further inspection, radiologists have access to raw data and can change the TR, TE and TI of the derived. Quantitative maps are also available for T1, T2 and PD and can be used for further evaluation of tissues.

In conclusion, MAGiC may be acceptable for clinical use in children; however, users should be aware of its limitations.[2] Noteworthy synthetic reconstructions rely on the quality of a single scan, so special care should be taken to minimize motion artifacts during this acquisition.

References

1. Tanenbaum LN, Tsiouris AJ, Johnson AN, Naidich TP, DeLano MC, Melhem ER, et al. Synthetic MRI for Clinical Neuroimaging: Results of the Magnetic Resonance Image Compilation (MAGiC) Prospective, Multicenter, Multireader Trial. AJNR Am J Neuroradiol. 2017 Jun;38(6):1103-1110.
2. Betts AM, Leach JL, Jones BV, Zhang B, Serai S. Brain imaging with synthetic MR in children: clinical quality assessment. Neuroradiology. 2016 Oct;58(10):1017-1026.

Technical inputs

- MAGiC is designed to fit in a routine (320 x 224) **5-minute scan** time with 3 mm slices and moderate resolution.
- MAGiC contrasts can be **customized to provide the best contrast**, in our opinion, especially PSIR and STIR (TI set to the optimal WM/GM contrast).
- MAGiC **can be post processed to provide other contrasts automatically** depending on the indication, a radiologist's preference or to add different contrasts that were not initially acquired.