Pediatric imaging with MAGiC

By So Mi Lee, MD, Assistant Professor, Department of Radiology, Kyungpook National University Medical Center, Daegu, South Korea

Discovery™ MR750

MAGiC Parameters

Age: 1-6 years old	
TR (ms):	5000
TE (ms):	22.8 (second TE is automatically decided)
TI (ms):	4 (saturation delay automatically calculated)
ETL (ms):	12
FOV (cm):	22
Slice thickness (mm):	4
Frequency (mXn):	320
Phase (mXn):	224
Scan time (min):	6:20

Age: less than 1 year old	
TR (ms):	4000
TE (ms):	23.2 (second TE is automatically decided)
TI (ms):	4 (saturation delay automatically calculated)
ETL (ms):	12
FOV (cm):	20
Slice thickness (mm):	4
Frequency (mXn):	320
Phase (mXn):	224
Scan time (min):	6:08

Introduction

Contrast-enhanced MR studies are a sensitive imaging study for the evaluation of brain pathology. Despite the diagnostic utility of using an MR contrast agent, there is concern regarding the accumulation of gadolinium in neuronal tissues.[1-3] As a result, many experts suggest if gadolinium is not needed for a particular exam, especially in pediatric patients, then it should not be administered.

Our institution has evaluated MAGnetic resonance image Compilation (MAGiC) for use in non-contrast imaging of pediatric patients with neurological disorders. Many of these young patients will require multiple follow-up MR scans and, therefore, the avoidance of MR contrast is desirable.

Sturge-Weber Syndrome (SWS) is a rare neurological disorder present at birth marked by a distinctive port-wine stain (facial nevus flammeus) on the forehead, scalp or around the eye. Many people afflicted with SWS experience seizures or convulsions. Other complications may include eye abnormalities, developmental delays and weakness on one side of the body. This disease usually worsens over time with clinical symptoms such as hemiparesis, mental retardation and seizures. Specific pathologies resulting from this disorder include leptomeningeal angioma and enlarged collateral vessels, such as transmedullary and subependymal veins. Demonstration of the extent of the angioma is critical in determining the patient's prognosis and the necessary extent of cortical resection for seizure management.

In the following case, the patient underwent conventional and synthetic imaging (with MAGiC), to determine the extent of disease and evaluate if the use of MAGiC without contrast may be utilized to replace conventional contrast-enhanced scans for the evaluation of SWS.

So Mi Lee, MD

Kyungpook National University Medical Center, Daegu in South Korea

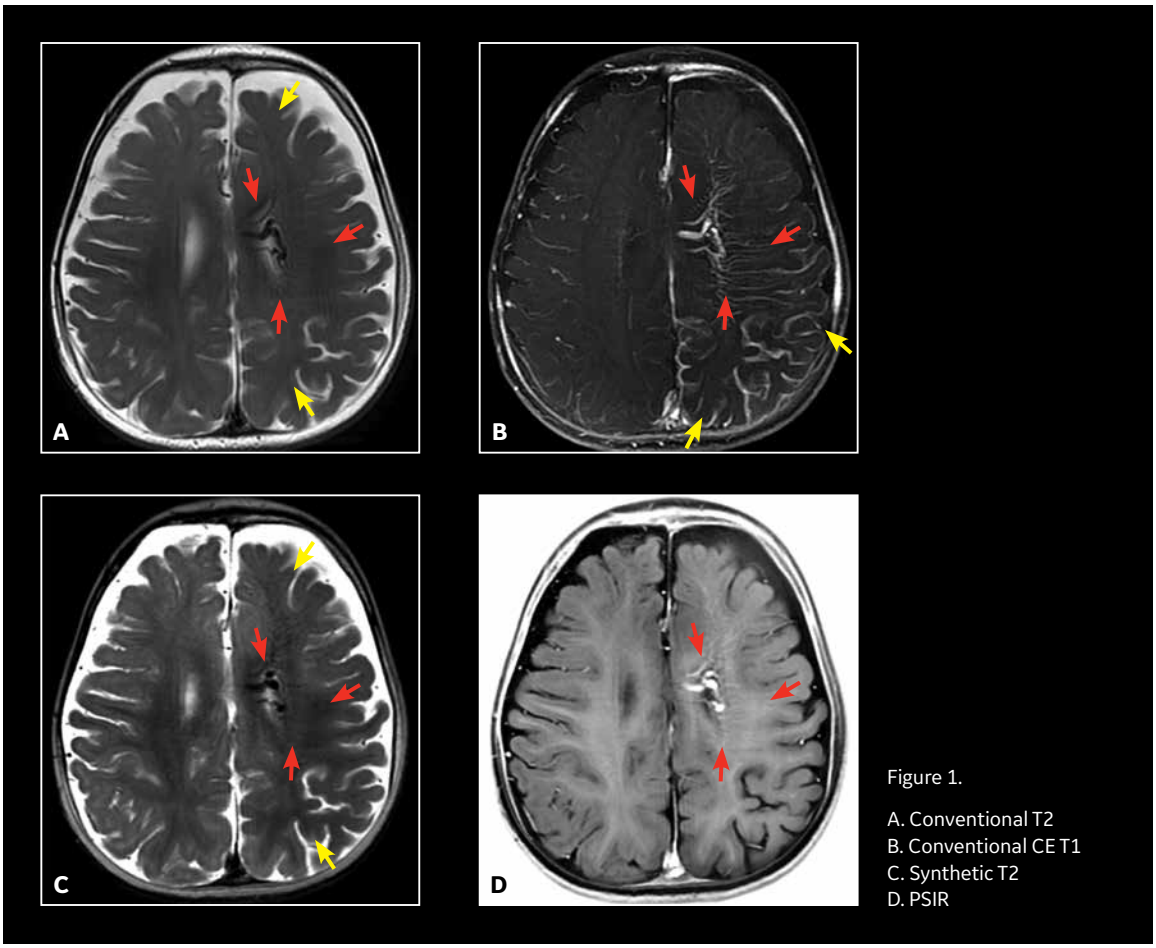

Figure 1.

A. Conventional T2
B. Conventional CE T1
C. Synthetic T2
D. PSIR

Patient history

A nine-month-old patient with an episode of focal seizure was referred for evaluation. The patient also had facial nevus flammeus (left side) and angioma involving the choroid of the eye.

MR findings

Both conventional and synthetic imaging with MAGiC were performed on this patient.

Conventional: Axial T2-weighted image (Figure 1A) shows minimal hypointensity of the left hemispheric white matter and dilated medullary and subependymal veins. The ipsilateral cerebral hemisphere shows mild atrophic change. On the contrast-enhanced image (Figure 1B) the leptomeningeal angioma especially involves the parieto-occipital region. Enlarged collateral vessels, such as subependymal and transmedullary veins, enlarged choroid plexus and marked enhancement of the choroid of the ocular globe are shown in the left side. These imaging features are consistent with SWS.

Using synthetic imaging (Figure 2B), the leptomeningeal angioma—the pathognomic feature of this pathology being most clearly depicted on contrast exam—can be demonstrated without the use of an MR contrast agent.

In addition, using MAGiC PSIR (Figure 1D), the dilated and enlarged collateral vessels as well as parenchymal atrophic changes (Figure 2C) can be well visualized without use of an MR contrast agent.

In this case, the white matter underlying the angioma typically shows prominent hypointensity on T2-weighted images compared to the remainder of the brain. This is most likely secondary to abnormal hypermyelination that presumably results from abnormal venous congestion or from repeated seizures. The synthetic imaging that includes myelin partial volume map as well as quantitative imaging such as T1, T2 and PD maps are useful for evaluation of early white matter changes in an infant with SWS.

Discussion

The use of synthetic imaging facilitated diagnosis of the patient's condition as well as the evaluation of the extent of the lesion without the use of a contrast agent. Concerns regarding intracranial

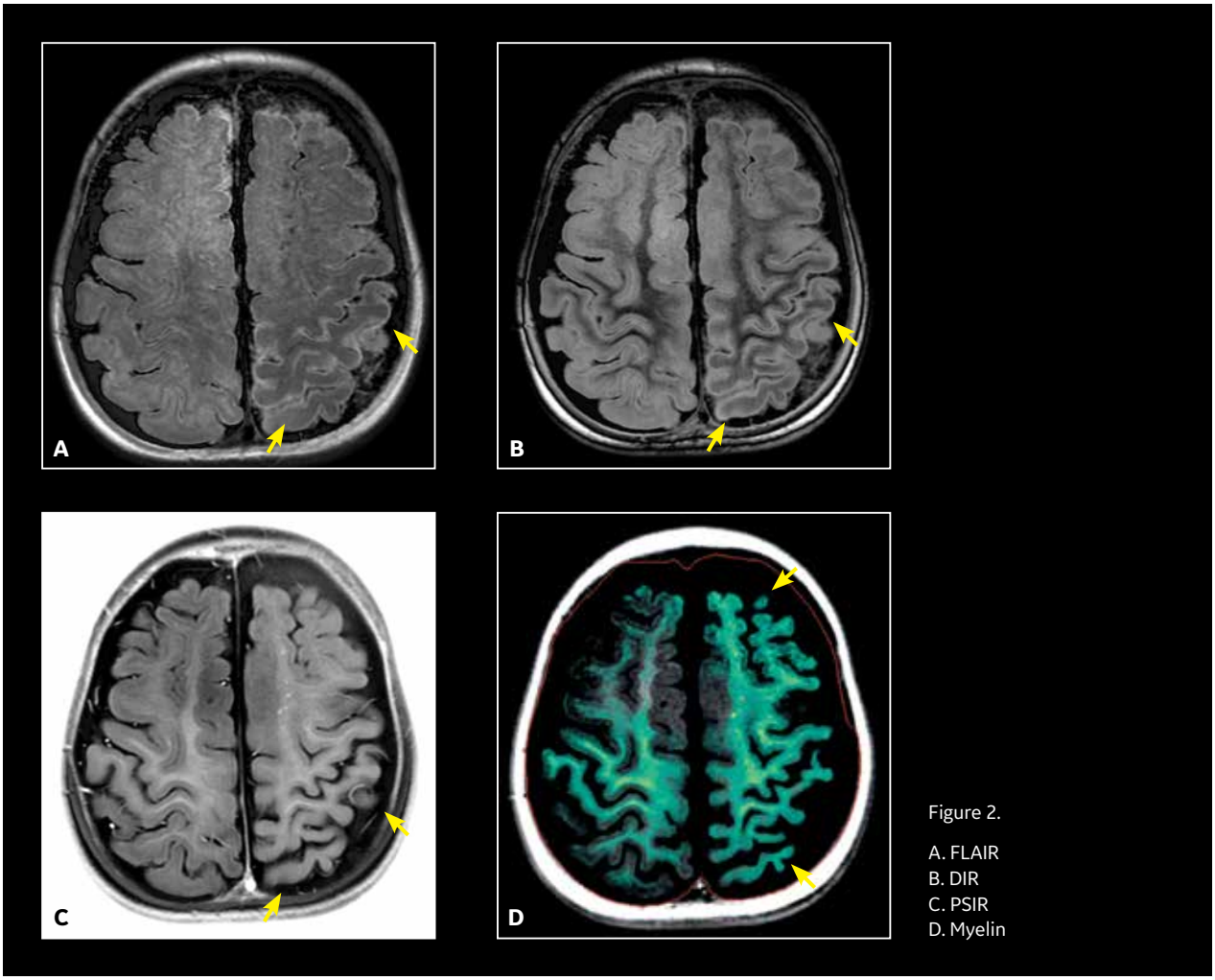

Figure 2.

A. FLAIR
B. DIR
C. PSIR
D. Myelin

accumulation of contrast agents may be alleviated in patient follow-up examinations with the use of MAGiC. However, the baseline examination should be performed with contrast-enhanced MR imaging to aid in a proper diagnosis.

In pediatric neuroimaging, assessment of dynamic processes during brain maturation is also important. In this respect, the quantification of tissue properties and myelin partial volume using synthetic imaging is very useful for evaluating underlying brain tissue and assessing brain development or change during follow-up examinations.

Image quality of synthetic T2-weighted and T1-weighted sequences were comparable with the conventional images, which is consistent with other findings in our department.[4] If synthetic imaging is used in clinical practice, dural angiomatosis can be depicted with DIR and leptomeningeal enhancement may be useful for evaluation of disease extent. Synthetic T2 FLAIR is still problematic due to partial volume artifacts in the interface between CSF and brain parenchyma, which may influence the evaluation of leptomeningeal angioma. However, PSIR and DIR, two sequences not included in conventional imaging, may compensate for this issue.[5-7]

References

1. Kanda T, Ishii K, Kawaguchi H, Kitajima K, Takenaka D (2014) High signal intensity in the dentate nucleus and globus pallidus on unenhanced T1-weighted MR images: relationship with increasing cumulative dose of a gadolinium-based contrast material. Radiology, March 2014; 270:834-841.
2. McDonald RJ, McDonald JS, Kallmes DF, et al. Intracranial Gadolinium Deposition after Contrast-enhanced MR Imaging. Radiology, June 2015; 275:772-782.
3. Ramalho J, Castillo M, AlObaidy M. High Signal Intensity in Globus Pallidus and Dentate Nucleus on Unenhanced T1-weighted MR Images: Evaluation of Two Linear Gadolinium-based Contrast Agents. Radiology, Sept 2015; 276:836-844.
4. Lee SM, Choi YH, Cheon JE, et al. Image quality at synthetic brain magnetic resonance imaging in children. Pediatr Radiol, June 22, 2017; doi: 10.1007/s00247-017-3913-y. [Epub ahead of print].
5. Hagiwara A, Nakazawa M, Andica C, et al. Dural Enhancement in a Patient with Sturge-Weber Syndrome Revealed by Double Inversion Recovery Contrast Using Synthetic MRI. Magn Reson Med Sci, 2016; 15:151-152.
6. Andica C, Hagiwara A, Nakazawa M, et al. The Advantage of Synthetic MRI for the Visualization of Early White Matter Change in an Infant with Sturge-Weber Syndrome. Magn Reson Med Sci, Oct. 11, 2016; 15:347-348.
7. Hagiwara A, Andica C, Hori M, Aoki S. Synthetic MRI showed increased myelin partial volume in the white matter of a patient with Sturge-Weber syndrome. Neuroradiology, Aug 26, 2017; doi: 10.1007/s00234-017-1908-x. [Epub ahead of print].