The Advantages of Synthetic MRI in Pediatric Patients
[Presidential Award Proceedings]

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Diagnostic imaging of pediatric patients sometimes can be challenging. Optimal parameter settings for the developing brain and shorter examination time are needed to give the most accurate diagnosis and a better experience to children.

Synthetic MRI is a method based on quantification of the T_1 and T_2 relaxation times, the proton density (PD), and the amplitude of the local radio frequency B_1 field by a single scan. QRAP-MASTER (Quantification of Relaxation Times and Proton Density by Multiecho acquisition of a Saturation-recovery using Turbo Spin-Echo Readout) method, which consists of multi-slice, multi-echo, and multi-delay acquisition, is used for quantification[1].

From the quantitative data, tailored contrast-weighted image with any combination of echo time (TE), repetition time (TR), and inversion time (TI) can be applied to each patient in order to evaluate brain diseases with a significant reduction in examination time (Fig. 1). The volumetric measurement obtained by automatic segmentation[2] and myelin map[3] for evaluating the presence of myelin are also features of synthetic MRI.

In our institute, we applied synthetic MRI to pediatric patients and found a few interesting cases that show the advantage of synthetic MRI in the evaluation of brain diseases, such as :

1. Meningeal pathologies :

A) Sturge-Weber Syndrome (SWS) :

Contrast-enhanced (CE) synthetic DIR that was used to null the CSF and minimize the signal of fat showed leptomeningeal and dural enhancement more clearly than CE synthetic FLAIR[4].

B) Meningitis

CE FLAIR has a high sensitivity to meningeal pathology but this sequence is not routinely performed[5]. In a case of a 7-week-old infant, enhancement in the subdural effusion area that represents contrast agent leakage secondary to meningitis was more clearly shown on the CE synthetic FLAIR and DIR with CSF and fat signals suppressed compared to conventional images or CE synthetic T_1WI[5]. With synthetic MRI, CE FLAIR and DIR can be easily made after the image acquisition[5].

2. Myelination of developing brain

Synthetic MRI can be used to show the ''accelerated myelination'' by doing a few things, as follows :

Keywords pediatric neuroimaging, synthetic MRI, quantitative MRI, automatic brain segmentation, myelin measurement

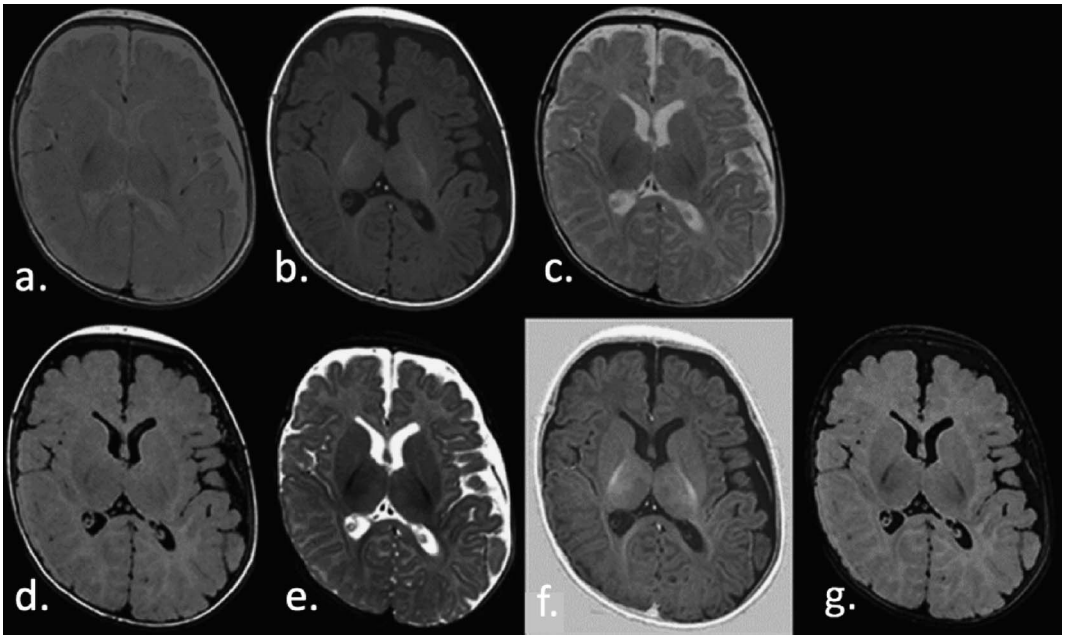

Fig. 1. Synthetic MR images of a 3-month-old patient with a developmental disorder. (a) Proton density (PD)-weighted image (WI), (b) T_1-WI, (c) T_2-WI, (d) fluid attenuated inversion recovery (FLAIR), (e) short tau inversion recovery (STIR), (f) phase sensitive inversion recovery (PSIR), (g) double inversion recovery (DIR) with cerebrospinal fluid (CSF) and fat signals suppressed.

- Synthetic T_2-WI with longer TR and TE shows abnormal white matter hypointensity more clearly compared to conventional T_2-WI[6].
- DIR can be used to suppress the non-myelinated white matter and CSF and highlight the myelinated area[6].
- Other features of synthetic MRI, such as the quantitative maps[6] and myelin map, also can be beneficial.

Despite the advantages of synthetic MRI shown above, there are also some limitations especially regarding of FLAIR image. Synthetic FLAIR image shows lower image contrast and higher noise level than conventional FLAIR, and brain parenchyma-CSF interface shows hyperintensity. Therefore, additional conventional FLAIR image is still needed.

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