A Hippocampal Lesion Detected by High-Field 3 Tesla Magnetic Resonance Imaging in a Patient with Temporal Lobe Epilepsy

YUKIO SAWAISHI, MAKOTO SASAKI, TAMIAMI YANO, AYA HIRAYAMA, JINZO AKABANE and GORO TAKADA

Department of Pediatrics, Akita University School of Medicine, Akita, Department of Radiology, Iwate University School of Medicine, Morioka, and Department of Pediatrics, Nakadori General Hospital, Akita, Japan

SAWAISHI, Y., SASAKI, M., YANO, T., HIRAYAMA, A., AKABANE, J. and TAKADA, G. A Hippocampal Lesion Detected by High-Field 3 Tesla Magnetic Resonance Imaging in a Patient with Temporal Lobe Epilepsy. Tohoku J. Exp. Med., 2005, 205 (3), 287-291 —— Nearly 80% of patients with temporal lobe epilepsy have some types of lesion identified by conventional 1.5 tesla (T) magnetic resonance imaging (MRI). We performed high-field 3 T MRI in a 5-year-old patient with recurrent complex partial seizures who was diagnosed as having right temporal lobe epilepsy based on the results of single photon emission computed tomography and ictal video-electroencephalogram monitoring, because 1.5 T MRI failed to detect any abnormalities in the suspected region. High-field 3 T MRI revealed a small high-intensity lesion on fast spin-echo short inversion time inversion-recovery images of the hippocampus, possibly responsible for the seizures. This is the first report detecting a hippocampal lesion by 3 T MRI, which could not be found by conventional 1.5 T MRI. ——— high-field MRI; 3 T MRI; hippocampus; mesial temporal sclerosis; temporal lobe epilepsy
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Technical and methodological advances in magnetic resonance imaging (MRI) have enabled preoperative diagnosis of mesial temporal sclerosis (MTS), the leading cause of intractable temporal lobe epilepsy (TLE) in adults, mainly on the basis of its characteristic findings: increased hippocampal signal on T2-weighted images, hippocampal atrophy, and disruption of the internal hippocampal structure (Jackson et al. 1993; Teixeira et al. 2003). Adulthood MTS is an established clinico-pathologic entity (French et al. 1993), but the etiologic problem has not been resolved perhaps because of difficulty in estimating the early stage of the pathology by conventional MRI. Recent pathologic studies of intractable TLE in childhood, which included patients with infantile-onset complex partial seizure (CPS), showed high frequency of dual pathology: MTS and temporal neocortical dysplasia (Mohamed at al. 2001; Bocchi et al. 2003; Diehl et al. 2003), suggesting that TLE in childhood may constitute a different category than in adults. However, the pathologic in-
However, she exhibited frequent episodes of CPSs, which often lasted for a few minutes, sometimes clustered over 30 times a day, and rarely generalized. Despite the addition of valproic acid (VPA), improvement of seizure frequency was only transient, and finally she was referred to Akita University hospital at age 4. Ictal video-EEG monitoring showed the seizures originating at the right mid-temporal region, and interictal single photon emission computed tomography (SPECT) demonstrated hypoperfusion over the right temporal lobe. However, 1.5 T MRI (Signa: General Electric, Milwaukee, WI, USA) showed no abnormalities in the suspected right temporal lobe, including the mesial temporal region. After replacing CBZ with zonisamide (ZNS), her seizure frequency gradually decreased to only a few times a day, and the duration of each seizure was less than a minute. As we could not completely control her seizures by adjusting the doses of VPA and ZNS, nitrazepam was added. Thereafter, her condition improved markedly with only a few episodes of seizures a month. The second MR scan was performed on the same 1.5 T

**CASE REPORT**

A female with a history of normal delivery and development was 2 years and 9 months of age, when her mother first noticed that she repeatedly blinked for seconds several times a day. Her medical and family histories showed no seizures. Because of increasing episodes of blinking, sometimes accompanied by several seconds of unresponsiveness, she was brought to a local hospital at age 3. Interictal electroencephalogram (EEG) showed right mid-temporal spikes both in sleep and awake, and carbamazepine (CBZ) was administered to her under a diagnosis of CPSs.

![Fig. 1. Images from the case of a 5-year-old patient with right temporal lobe epilepsy.](image-url)

A: Coronal T2-weighted image (4,500/97 [TR/TE]; matrix, 256 × 224; field of view, 18 cm; section thickness, 4 mm), obtained from the 1.5 T MR scanner, shows no abnormalities in the right hippocampus (arrow).

B: Corresponding fast short TI inversion recovery (STIR) image (5,400/100/13.4 [TR/TI/TE]; matrix, 512 × 384; field of view, 20 cm; section thickness, 3 mm), obtained from the 3 T MR scanner, shows a high-signal lesion in the right hippocampus (arrow), which appears to be slightly large compared with the left hippocampus.
unit, when she was 5 years and 4 months old. The result was negative again. Then, a month later, higher-field MR scanning was performed on a 3 T Signa VH/i scanner (General Electric) after obtaining informed consent. The study was approved by the Ethical Committee at the Iwate Medical University. Using fast spin-echo short inversion time inversion-recovery (STIR) imaging, we were able to see on the coronal section a small high-signal lesion in the right hippocampus, measuring 2 mm in diameter, and possibly responsible for the seizures (Fig. 1B). The ipsilateral hippocampus was slightly larger than the contralateral. On the sagittal views (Fig. 2), the internal architecture of the right hippocampal head (Fig. 2A) appeared obscure compared with that of the left (Fig. 2B). We found no other abnormalities in the brain, including in the neocortical temporal lobe. Without surgical treatment, the recurrent CPSs were controlled by gradually increasing the dose of nitrazepam. Thus, we could not pathologically confirm the suspected hippocampal lesion.

**DISCUSSION**

Based on the seizure semiology and ictal video-EEG monitoring, the patient was suspected to have right TLE, which confirmed by interictal SPECT, showing definite hypoperfusion over the right temporal lobe, although conventional 1.5 T MRI failed to detect any abnormalities in the brain. Interictal SPECT has less diagnostic value than ictal SPECT for localization-related epilepsies, but still serves about half of the child patients with TLE in grossly localizing epileptic foci (Duncan et al. 1996). For further narrowing of an epileptogenic zone, the use of magnetoencephalography was considered, but it was difficult due to a lack of cooperation. At 5 years and 5 months of age, a month after the second 1.5 T MRI study, the patient had a third MRI examination with the high-field 3 T unit. During the one-month interval between the two MRI studies, there were no changes in the frequency and symptoms of CPSs, nor was the drug therapy changed. Thus, assuming that each study reflected a common condition, we considered that the hippocampal lesion was too small to be detected by 1.5 T MRI. In MRI studies using the 3 T unit, we routinely adopt fast STIR images instead of T2-weighted images, because, on the former images, spin density, and T1 and T2 relaxations synergistically affect image contrast, improving the gray matter-white matter and brain-CSF contrast (Dwyer et al. 1988).

Reports addressing clinical application of high-field MRI to the evaluation of MTS are limited. Briellmann et al. (2001) denied any major advantage in using 3 T MRI compared with 1.5 T
MRI for hippocampal volume measurements of eight adult healthy controls, and speculated that anatomic images were already of very high standard at 1.5 T. However, a high-field MR system has been expected to provide substantially higher anatomic resolution due to its higher signal-to-noise ratio (S/N) compared to conventional systems (Nakada 1999). Thus, we had applied the 3 T MRI unit to detecting a strongly-suspected occult lesion and revealed the abnormal spot, measuring about 2 mm in diameter, which was located in the center of the right hippocampal body. Considering its location, size, and shape, the lesion may occupy the region around the end folium and dentate gyrus of the hippocampus. Moreover, the alteration of the hippocampus on fast STIR images (nearly equivalent to T2-weighted images) without atrophy may represent a specific pathology in the early stage of a continuous process, possibly leading to full-blown MTS. However, without surgery, the pathology of the small hippocampal lesion is a matter of speculation.

Jackson et al. (1994) reported six patients with pathologic evidence of MTS but no detectable hippocampal atrophy, and proposed that the presence of gliosis, possibly reflected by increased signal on T2-weighted images, would be a more important prerequisite to epileptogenicity in the hippocampus than neuronal loss. Briellmann et al. (2002) showed that T2-weighted signal intensity in the hippocampus was mainly influenced by gliosis in the dentate gyrus, and further confirmed the importance of increased signal on T2-weighted images in epileptogenicity of the hippocampus. They speculated that reactive astrocytes possibly had a larger amount of cytoplasmic water, which could influence the MR signal and the overall hippocampal volumes. Thus, in the present case, given the beginning of MTS, transient mild hypertrophy of the hippocampus is plausible, although the volume gain may be progressively counterbalanced by the volume deficit induced by neuronal cell loss.

Another possible pathology of the otherwise occult lesion is congenial disorganization of granular cells in the dentate gyrus (Blümcke et al. 2002; Thom et al. 2002), which may produce an underlying condition to develop both febrile seizures and MTS. Moreover, de Lanerolle et al. (2003) made exhaustive investigations on the pathology of surgically-resected hippocampi from 151 patients with intractable TLE and, on the basis of pathophysiology, categorized them into several groups, which may represent differing causative mechanisms. Despite these progresses in the pathology, there are no corresponding neuroimaging data to characterize such several pathologic categories. Thus, the next steps of neuroradiological interest are to visualize subtle differences among each category of MTS, occult lesions of an early stage of MTS, or slight congenital alterations in the hippocampus.

Lack of pathologic investigation limits the value of this case report, but it is worth noting that this is the first report on application of high-field 3 T MRI in the evaluation of a small hippocampal lesion undetectable by conventional 1.5 T MRI. In conclusion, high-field MR scanning may contribute, not only to detecting false-negative patients with intractable TLE, but also to elucidating the preoperative pathogenic processes of MTS.

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References


