



Contents lists available at ScienceDirect

Journal of Clinical Neuroscience

journal homepage: [www.elsevier.com/locate/jocn](http://www.elsevier.com/locate/jocn)

## Case report

## Epilepsy surgery for a patient with neurofibromatosis type 1 concomitant with moyamoya syndrome

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## ARTICLE INFO

## Article history:

Received 26 August 2018

Accepted 6 October 2018

Available online xxxx

## Keywords:

Neurofibromatosis type 1

Moyamoya syndrome

Mesial temporal lobe epilepsy

Epilepsy surgery

Superficial temporal artery-middle cerebral artery anastomosis

## ABSTRACT

**Background:** Epilepsy associated with neurocutaneous disorders is well known, and the prevalence of epilepsy among patients with neurofibromatosis type 1 (NF1) ranges from 4% to 13%. However, epilepsy surgery for patients with NF1 is not commonly performed.

**Case description:** We report the case of a patient with medically intractable mesial temporal lobe epilepsy (mTLE) concomitant NF1 and moyamoya syndrome (MMS) who had already undergone bilateral superficial temporal artery-middle cerebral artery anastomosis at 17 years old. As the standard temporal approach was unavailable, we evaluated the patient with neurologists, radiologists, neurosurgeons and neuropsychologists to identify the safest trajectory for epilepsy surgery. The patient underwent the right selective amygdala hippocampectomy from the posterior auricle part at 32 years old and obtained freedom from seizures.

**Conclusion:** To the best of our knowledge, this represents the first surgical case report for mTLE concomitant with NF1 and MMS.

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## 1. Introduction

Neurofibromatosis type 1 (NF1) is a neurocutaneous disorder, and is known as an autosomal dominant condition with a sporadic occurrence of 30–50% [1–3].

Epilepsy associated with neurocutaneous disorders is well known to be represented by tuberous sclerosis complex [4], Sturge-Weber syndrome [5] and neurocutaneous melanosis [6]. The prevalence of epilepsy in patients with NF1 ranges from 4% to 13% [7,8], but has generally been underrecognized.

Moyamoya disease is a rare inherited cerebral disorder of unknown etiology characterized by obliteration of the internal carotid artery and its branches, with concomitant development of an abnormal network of collateral vessels [9].

Associations between NF-1 and vascular disorders are not uncommon [10], and associations between NF-1 and specific cerebrovascular disorders such as moyamoya syndrome (MMS) [11] have been reported [12].

We report the case of a patient with NF1 concomitant with MMS who exhibited medically refractory mesial temporal lobe epilepsy (mTLE), and who had previously successfully undergone superficial temporal artery (STA)-middle cerebral artery (MCA) anastomosis. Epilepsy surgery was able to be performed in this case even though the standard temporal approach was unavailable.

## 2. Patient and method

## 2.1. Case report

A 32-year-old right-handed woman was referred from a local hospital. She had experienced epileptic seizures from 18 months old, in the form of rotatory seizure to the right side, eye deviation to right side, oral automatism and dystonic posture of the left hand with impaired awareness. These focal onset seizures were sometimes followed by bilateral tonic-clonic seizures. NF1 was diagnosed at 5 years old. She underwent close examinations and magnetic resonance angiography (MRA) revealed narrowing of the distal segments of both internal carotid arteries. She was diagnosed with MMS at this time. At 17 years old, she underwent bilateral STA-MCA anastomosis for the MMS. As seizures had become medically intractable, she was referred to other hospitals for epi-

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lepsy surgery in her twenties. However, she had not met the indications for epilepsy surgery. As seizures gradually worsened, she was referred to our facility.

She underwent long-term video electroencephalography (VEEG), serial magnetic resonance imaging (MRI), MRA, functional MRI, neuropsychiatric evaluation, iomazenil (IMZ), 99 m technetium ethyl cysteinate dimer (ECD) single-photon emission computed tomography (IMZ-SPECT), fluoro-deoxyglucose (FDG) positron emission tomography (FDG-PET), and angiography.

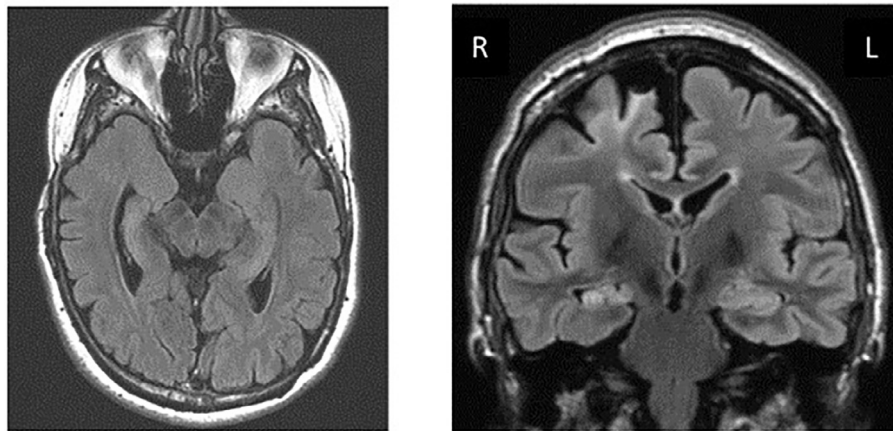
Based on these findings, discussions were held with neurologists, radiologists, neurosurgeons and neuropsychologists regarding whether the patient could be a candidate for epilepsy surgery.

## 2.2. Ethics approval

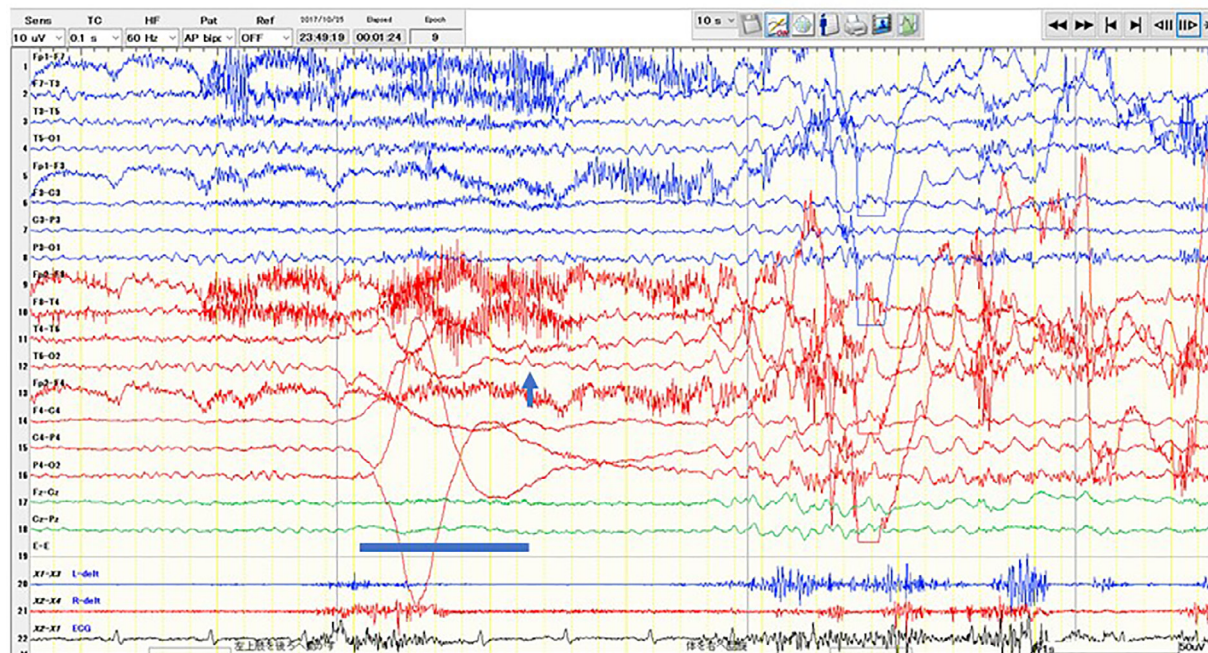
Written informed consent for publication of case details was obtained from the patient. This study was approved by the ethics committee at Seirei Hamamatsu General Hospital.

## 3. Results

Serial MRI showed right hippocampal atrophy (Fig. 1). Interictally, VEEG showed frequent epileptiform discharges in the right fronto-temporal areas. Ictally, VEEG showed diffuse amplitude attenuation over the right hemisphere for 1–2 s, followed by rhythmic theta activities arising from the right posterior head region spreading to the right fronto-temporal area (Fig. 2). Clinically, she exhibited rotation to the right side with loss of awareness at the time. VEEG also showed frequent non-convulsive status epilepticus. IMZ-SPECT and ECD-SPECT showed decreased accumulation in the right frontal and right mesial temporal areas. FDG-PET showed metabolic abnormality in right mesial temporal area. The results of neuropsychiatric evaluation were: full-scale intellectual quotient (IQ), 60; verbal IQ, 66; and performance IQ, 59. The fMRI test showed left hemisphere language dominance. Angiography showed bilateral STA-MCA anastomotic flows into the internal carotid arteries. Little collateral flow from bone or skin was present

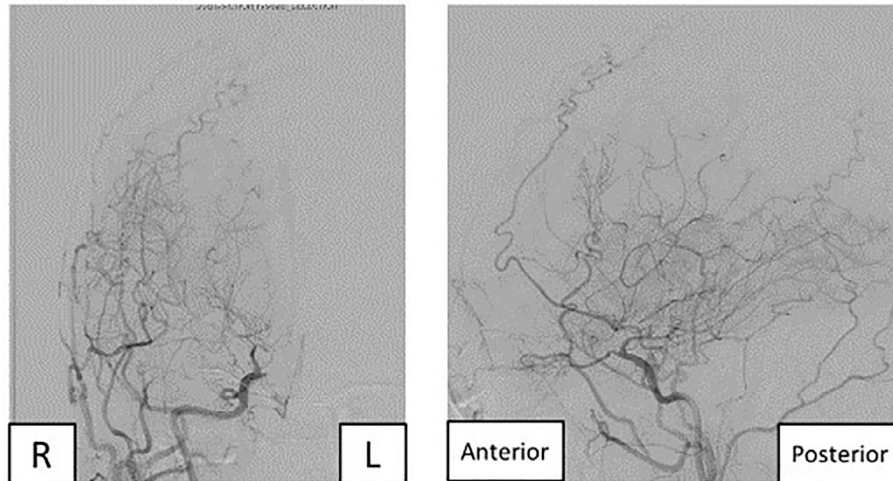


**Fig. 1.** Preoperative magnetic resonance imaging (MRI). Axial (left) and coronal (right) views from fluid attenuation inversion recovery (FLAIR) show high-intensity areas in the right mesial temporal lobe.

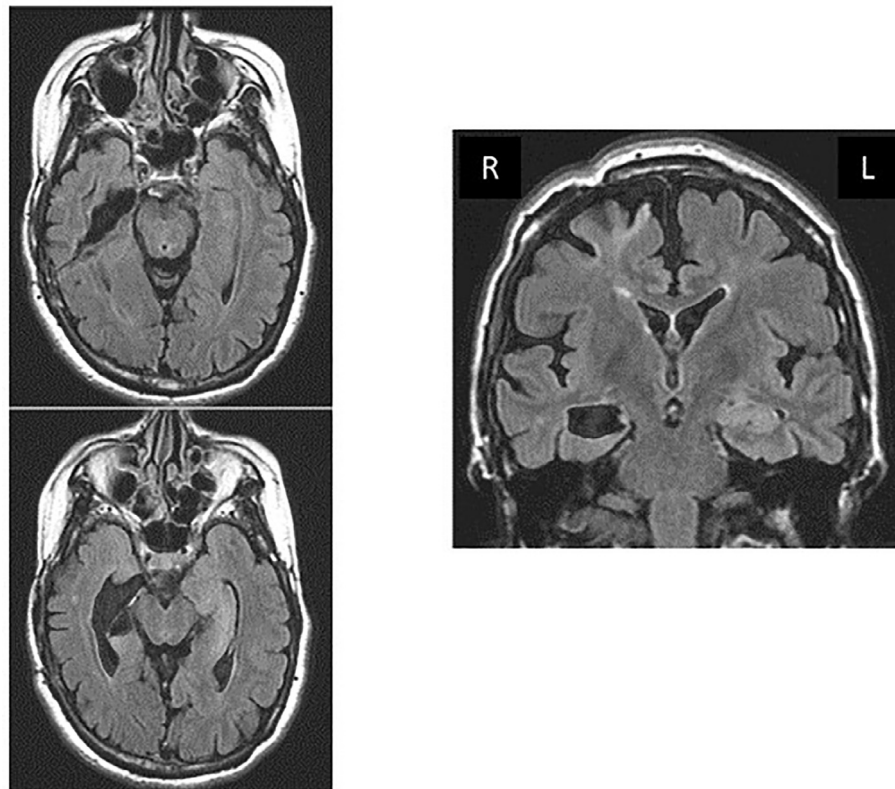


**Fig. 2.** Ictal electroencephalography. Diffuse amplitude attenuation over the right hemisphere for 1.5 s (underlined) with motion artifacts followed by rhythmic sharply contoured theta activities (arrow) starting over the right posterior head region.





**Fig. 3.** Lateral (left) and anteroposterior (right) views from angiography. Angiography shows anastomotic flow from the superficial temporal artery to the middle cerebral artery.



**Fig. 4.** Postoperative MRI. Postoperative axial (left) and coronal (right) views from FLAIR show complete removal of the right hippocampus.

(Fig. 3). We diagnosed the patient with right mTLE associated with NF1 and MMS. As the standard temporal approach was unavailable for this patient because of anastomotic flow from the STAs compensating the internal cerebral arteries, we held interdisciplinary discussions for this patient to identify the safest trajectory to approach the right hippocampus. We concluded that we could make a skin incision in the area of the right posterior auricle, which appeared comparatively avascular on angiography.

We performed right selective amygdala hippocampectomy. A linear, 5-cm skin incision behind the auricle was carried out to avoid injury to the anastomotic flow. A 3-cm craniotomy at the asterion with superior and anterior extensions was made.

A U-shaped dural flap with the base along the side of the transverse sinus was created to expose the middle temporal gyrus. From this cortex, we performed transcortical selective amygdala hippocampectomy (Fig. 4). The patient has since remained seizure-free for 6 months on lacosamide at 200 mg/day only. The neuropathological diagnosis was hippocampal sclerosis International League against Epilepsy type 1.

#### 4. Discussion

Guo reported that 15 (4.8%) of 312 patients with NF1 had vasculopathy [13]. Among those were 2 patients with epilepsy. Barba

[1] collected data from 25 European epilepsy surgery centers on patients with NF1 who had undergone surgery for drug-resistant seizures, and identified only 12 patients from eight centers. Epilepsy surgery for NF1 thus appears quite rare. This might be due to the fact that epilepsy surgery requires a strongly interdisciplinary approach [14–16]. As NF1 + MMS + mTLE is a more complicated situation, realistic interdisciplinary approaches are required. This might be the reason the present report represents the first description of epilepsy surgery for NF1 + MMS + mTLE. However, as MMS is not uncommon in NF1 [2,17] and hippocampal sclerosis has been reported in association with NF1 [18], many patients with NF1 + MMS + mTLE must have remained unoperated. The patient had not been considered a candidate for epilepsy surgery for 15 years after the STA-MCA. The standard temporal approach was unavailable and the trajectories were limited due to possible injury to the STA-MCA anastomosis, which might be why she had not been a candidate despite long-term medically intractable seizures. This type of patient should be discussed in a multidisciplinary manner with specialists such as neurologists, radiologists, neurosurgeons, and neuropsychologists, to clarify reasonable surgical approaches. Epilepsy surgery should not be discouraged for such cases.

### Conflict of interest

None.

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