

## Case Report

# Identification of non-convulsive status epilepticus with bradylalia using arterial spin-labeling magnetic resonance imaging

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**Case:** Non-convulsive status epilepticus (NCSE) is among the differential diagnoses of decreased consciousness, but often presents a diagnostic challenge. A 65-year-old woman was admitted to our emergency department with bradylalia. No abnormal finding was detected by computed tomography or magnetic resonance imaging. Subsequently, acquired arterial spin-labeling images showed hyperperfusion in the right hemisphere.

**Outcome:** After the examination, the patient began experiencing left hemifacial seizures, which were relieved by diazepam; however, she was still agitated. Ictal confusion due to NCSE was suspected. Electroencephalography revealed periodic, generalized epileptiform activities with brief seizures of facial muscles by intermittent photic stimulation. Another supportive case of NCSE detected by arterial spin-labeling from a 56-year-old right-handed man has also been presented.

**Conclusion:** Arterial spin-labeling magnetic resonance perfusion imaging provides valuable information regarding cerebral perfusion status in NCSE patients in emergency/acute settings.

**Key words:** Arterial spin-labeling perfusion, central nervous system, emergency, MRI, non-convulsive, status epilepticus

## BACKGROUND

PATIENTS WITH SUDDEN, transient alteration of consciousness as represented by decreased verbal response may frequently be referred from ambulance services or the emergency department. Non-convulsive status epilepticus (NCSE) should be included among the differential diagnoses, but often presents a diagnostic challenge.<sup>1</sup> Non-convulsive status epilepticus includes both generalized (absence or petit mal seizure) and complex partial status epilepticus, and its diagnosis usually requires electroencephalographic (EEG) confirmation.<sup>2</sup> However, in individuals who do not

have a prior history of epilepsy and acute neurological problems, accurate diagnosis of NCSE is often delayed and appropriate intervention might not be initiated.

Perfusion-based magnetic resonance imaging (MRI) using arterial spin-labelled (ASL) sequences is becoming a more commonly used tool for the diagnosis of patients in different clinical settings (stroke, tumors, focal epilepsy, or dementia).<sup>3</sup> Here, we describe two cases of NCSE who presented mainly with bradylalia and were diagnosed using ASL images.

## CASE 1

A 64-year-old right-handed woman with a history of a non-specific psychic aura was transported to our hospital in an ambulance with fatigue and bradylalia. On admission, she had a body temperature of 36.8°C, blood pressure of 180/110 mmHg, heart rate of 110 b.p.m., respiratory rate of 18 breaths/min, and SpO<sub>2</sub> of 97% (room air). Her verbal response was impaired, but she was able to function with no apparent seizures. Hematology, electrocardiography and chest X-ray results indicated no abnormalities.

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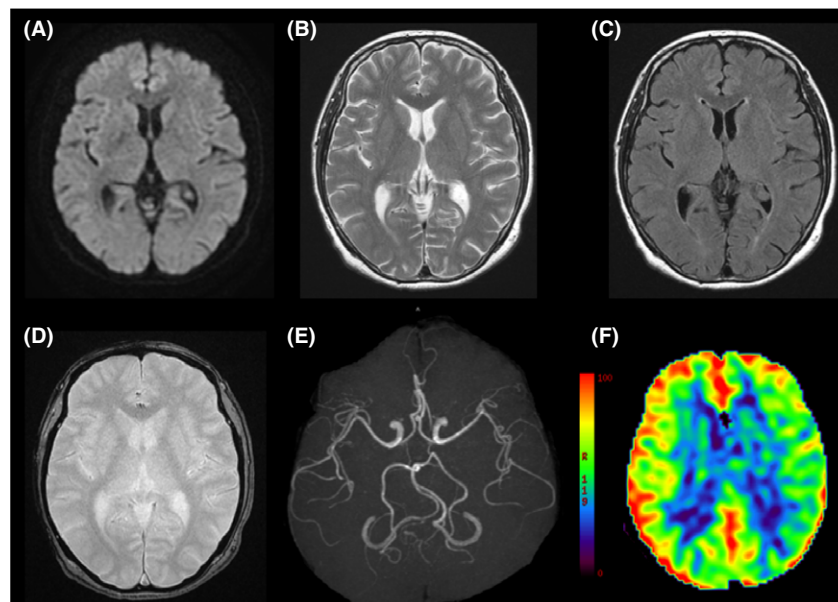
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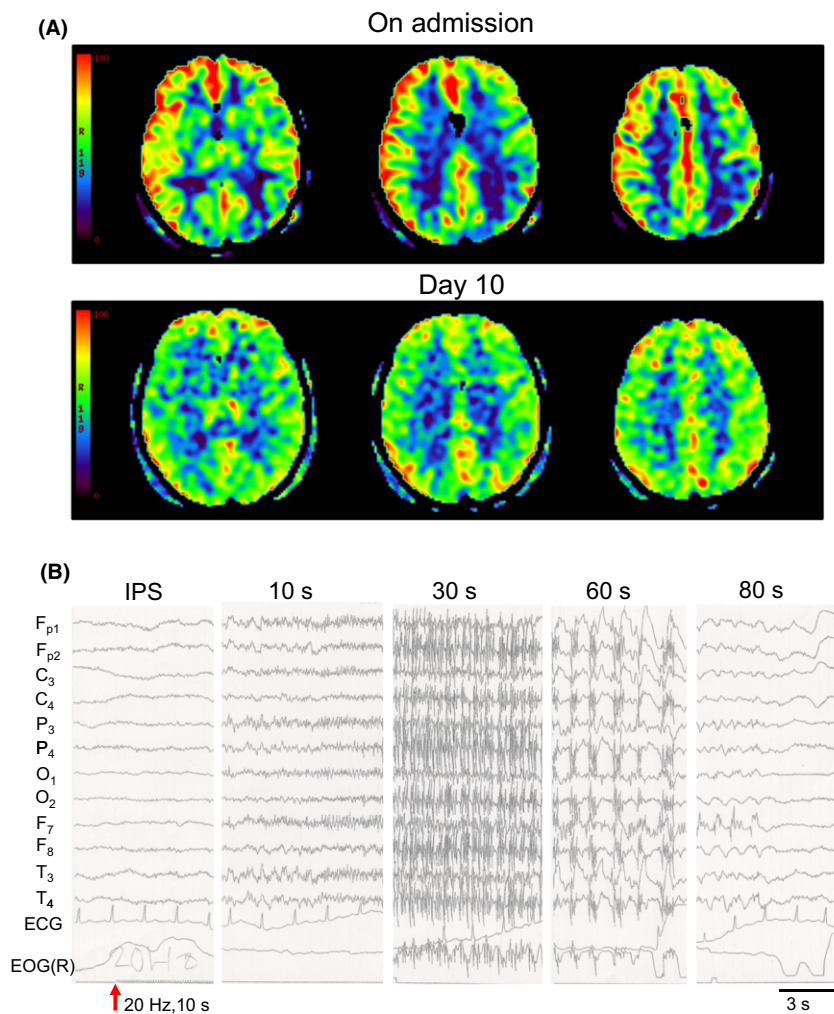
An emergency computed tomography scan of the head showed no abnormal findings, including intracranial bleeding and trauma. Magnetic resonance imaging, including T2 and fluid-attenuated inversion recovery using a 1.5 T MRI scanner (SIGNA; GE Healthcare, Little Chalfont, Buckinghamshire, UK) revealed mild periventricular white matter ischemic changes, but there was no diffusion restriction on the diffusion-weighted image nor findings suggesting bleeding on T2\*-weighted images (Fig. 1A–D). Magnetic resonance angiography showed a mildly increased signal intensity of the left middle cerebral artery with no arterial stenosis-occlusive lesions (Fig. 1E). Subsequently, acquired ASL images using pseudo-continuous arterial spin-labeling (pCASL) perfusion (3D ASL, HDxtVer 23; GE Healthcare) showed focal hyperperfusion in the right temporal region (Figs. 1F, 2A). To achieve equivalent slice positions and coverage as the simultaneous 3-D multislice fast spin-echo (field of view, 24 cm), the 3-D ASL used 4-mm contiguous slices. In the pCASL approach, we used multiple post-label delay (PLD) values, as the hemodynamic information made available by quantifying arterial transit time delays can improve quantification of cerebral blood flow (CBF) or serve as useful hemodynamic measures in and of themselves.<sup>4</sup> Labeling parameters were: repetition time (TR)/echo time (TE) = 4,546 ms/10.47 ms for PLD of 1,525 ms (scan time = 2 min 32 s) (default standard); TR/TE = 4,303 ms/

10.47 ms for 1,025 ms (scan time = 2 min 26 s) (short PLD); and TR/TE = 4,758 ms/10.47 ms for 2,525 ms (scan time = 2 min 48 s) (long PLD). The flip angle for each parameter was 155°.

After the MRI acquisition, the patient became agitated and started experiencing a generalized seizure that started in the left face, which was relieved by a bolus i.v. injection of diazepam (5 mg). However, she was still agitated and was unable to function and think with customary speed. Ictal confusion due to NCSE was suspected, and thus, an i.v. infusion of levetiracetam (1,000 mg) was immediately given; thereafter, her symptoms resolved gradually. After being admitted to the intensive care unit, the neurological examination was unremarkable except for a short-term amnesic deficit that diminished within 12 h. An EEG on the second day in hospital showed decreased photic drive response in the right hemisphere to intermittent photic stimulation (20 Hz, 10 s) followed by periodic, generalized epileptiform activities with contamination of muscle artifacts accompanied by brief seizures of facial muscles, terminating in the baseline EEG patterns within 80 s (Fig. 2B). Sodium valproate was initiated at a daily dose of 400 mg. Follow-up MRI was carried out on the 10th day in hospital in response to the patient having been asymptomatic for more than 24 h; the scan showed normalized CBF (Fig. 1D–F). The follow-up EEG showed disappearance of the epileptiform activity,



**Fig. 1.** Imaging acquired on admission of a 64-year-old woman with non-convulsive status epilepticus. A, Magnetic resonance (MR) diffusion-weighted (scan time, 56 s). B, T2-weighted (scan time, 2 min 16 s). C, Fluid-attenuated inversion recovery (scan time, 2 min 46 s). D, T2\*-weighted (scan time, 2 min 4 s). E, MR angiography (scan time, 5 min 24 s). F, Arterial spin-labeling perfusion map (post-label delay of 1,525 ms [default standard]; scan time, 2 min 32 s) shows states of hyperperfusion as focal areas of signal intensity increase in the right hemisphere.



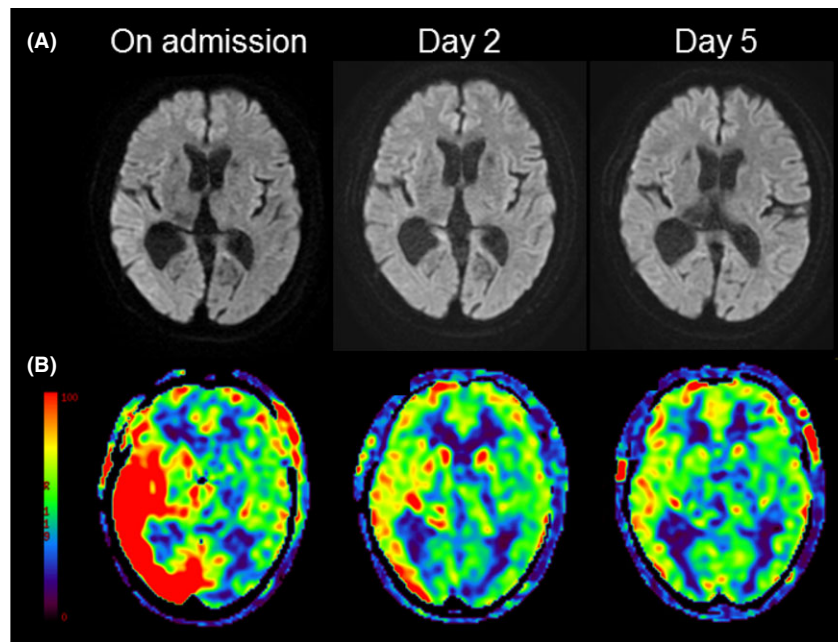
**Fig. 2.** Imaging and electroencephalography (EEG) of a 64-year-old woman with non-convulsive status epilepticus. A, Arterial spin-labelling (ASL) perfusion map depicts states of hyperperfusion (short post-label delay [PLD] of 1,025 ms) as focal areas of signal intensity increase in the right hemisphere on admission, which was diminished by antiepileptic treatment on follow-up exam 10 days later. In this case, standard PLD (1,525 ms) was used for the follow-up study because of incomplete labelled blood in the whole brain. B, EEG reveals decreased photic drive response in the right hemisphere (middle left panel), followed by periodic, generalized epileptiform discharges with muscle artifact contaminations (middle right panel), terminating in the baseline patterns after presenting right occipital dominant 3 Hz slow waves (right panel). ECG, electrocardiogram; EOG(R), electrooculogram for the right eye; IPS, intermittent photic stimulation (20 Hz, 10 s) (left panel).

confirming responsiveness to the antiepileptic drug. The patient was discharged from the hospital 2 weeks after the onset of symptoms, and at 3 months, her symptoms were effectively controlled in the outpatient clinic.

## CASE 2

**T**HIS 56-year-old right-handed man was transported to our hospital by ambulance due to persistent bradylalia. He had experienced intracerebral hemorrhage 9 years ago

but had no history of epilepsy. On admission, he had no evidence of seizures or stroke-like symptoms. Hyperperfusion around the scar was more prominently detected by ASL rather than increased cortical abnormal signals on diffusion-weighted imaging (Fig. 3). While waiting for admission to a hospital bed, the patient experienced a generalized seizure that started with jerking of the left face, which was resolved by repeated bolus i.v. injections of diazepam (5 mg) followed by an i.v. infusion of fosphenytoin (750 mg). An EEG on the second hospital day revealed slow wave



**Fig. 3.** Non-convulsive status epilepticus in a 52-year-old man detected by magnetic resonance imaging (MRI)—pseudo-continuous arterial spin-labeling (ASL). Diffusion-weighted (A) and ASL perfusion MRI (B). ASL perfusion map (short post-label delay of 1,025 ms) depicts states of hyperperfusion as focal areas of signal intensity increase in the right temporal lobe on admission, which was diminished by antiepileptic treatment until day 5 of the symptom onset.

discharges of 2–3 Hz with interspersed spikes and sharp-waves occurring in relative right hemisphere dominance. The patient had no recurrence of the symptoms or disappearance of the EEG and MRI abnormalities with sodium valproate (400 mg/day). He was discharged 10 days later.

## DISCUSSION

**S**UBTLE CONVULSIONS OR NCSE accounts for approximately 20% of status epilepticus.<sup>5</sup> In previous reports, the initial diagnosis of NCSE with a first episode of protracted ictal confusion had been erroneously reported to be either dementia, a transient ischemic attack, a metabolic disorder, or a psychiatric disorder.<sup>6,7</sup> To our knowledge, this is the first report to identify NCSE in the acute setting using the ASL perfusion MRI in an older ambulatory adult who presented mainly with bradylalia.

Non-convulsive status epilepticus is a term that covers a range of disparate conditions, denoting prolonged electrographic seizure activity (set arbitrarily at 30 min) with resultant non-convulsive clinical symptoms.<sup>8</sup> However, reports on hemodynamic or EEG changes during seizures in an emergency setting are rare as this technique presents multiple limitations for acquiring images in the peri-ictal period.<sup>4,7</sup> In fact, there continues to be difficulties and controversies with regard to determining abnormal periodic

discharges in an EEG as epiphenomena in severely injured brains or as harmful epileptiform discharges that could lead to additional brain injury.<sup>6</sup>

The choice of PLD has shown to be a compromise, such that signal-to-noise ratio is acceptable and that in the large majority of cases the ASL signal will accurately reflect CBF.<sup>4</sup> In our cases, the choice of standard or shorter PLD ( $\leq 1,525$  ms) could increase the likelihood of delivery of labelled blood to the imaging region affected by NCSE. Further trials and experience in an additional ASL sequence in routine MR protocol with recommended single/multiple PLD methods are necessary to determine its reliability as an emergency diagnostic method of NCSE.

## CONCLUSION

**E**MERGENCY ASL PERFUSION MRI can provide practical information regarding cerebral perfusion status in elderly patients with NCSE in acute settings.

## DISCLOSURE

Approval of the research protocol: N/A.

Informed Consent: Informed consent was obtained from the patient for publication of this case report.

Registry and the registration no. of the study/trial: N/A.

Animal studies: N/A.

Conflict of interest: None declared.

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