



## Convulsive-like symptoms as initial indications of basilar artery occlusion: A case series study

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### ABSTRACT

#### Background:

There is little evidence regarding relevant clinical findings for the early diagnosis of basilar artery occlusion (BAO) in the prehospital setting. We focused on “convulsive-like symptoms”, including convulsive seizures and other convulsive-like movements, and examined the frequency and clinical characteristics of patients with BAO having these symptoms as an initial symptom.

#### Methods:

In this single-center case series from 2015 to 2020, we identified patients who underwent endovascular therapy (EVT) for BAO and presented with convulsive-like symptoms between the stroke onset and initiation of emergency medical care. The clinical course and neurological findings were evaluated by reviewing the run sheets of emergency medical services and medical records.

#### Results:

Among a total of 32 patients with BAO, 7 (21.9%) developed convulsive-like symptoms before EVT, of whom 6 were men and whose median age was 72 (interquartile range, 69–78) years. These 7 patients had no history of epilepsy or stroke, and the semiology of convulsive-like symptoms was generalized in 6 of them. In only 3 of the 7 cases, emergency medical services could consider the possibility of stroke on scene, and time from hospital arrival to groin puncture was longer in those who were transported without suspicion of stroke.

#### Conclusions:

21.9% of our patients who underwent EVT for BAO experienced convulsive-like symptoms initially. We should be vigilant in the possibility of BAO when managing the first-time generalized convulsive-like symptoms occurring in older patients, which may enable to adequate triage and better management for patients with acute BAO.

### 1. Introduction

Convulsive seizure is one of the complications associated with acute stroke, and early-onset seizures are defined as those that occur within 2 weeks of stroke onset [1]. Among them, convulsive seizures occurring as the initial symptom of stroke were reported to affect 0.16% of a large cohort of ischemic stroke patients [2].

Basilar artery occlusion (BAO), a fatal type of ischemic stroke,

accounts for approximately 10% of all large vessel occlusions (LVO) treated by endovascular therapy (EVT) [3]. Several case reports have described convulsive seizures that occur as a rare initial symptom of BAO [4–8]. However, BAO can also cause decorticate rigidity, decerebrate rigidity, or other convulsive-like movements including shivering, jerky, or intermittent shaking movements due to acute brainstem dysfunction, in which witnesses often cannot distinguish from convulsive seizures [9]. To date, no clinical studies have comprehensively

*Abbreviations:* BAO, indicates basilar artery occlusion; LVO, large vessel occlusion; EVT, endovascular therapy; EMS, emergency medical services; t-PA, tissue plasminogen activator; mRS, modified Rankin scale; mTICI, modified Thrombolysis in Cerebral Infarction.

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evaluated these abnormal movements as convulsive-like symptoms and investigated their clinical significance in BAO cases.

Considering the heterogeneity of symptoms, the early diagnosis of BAO is often challenging [10]. Furthermore, no universal prehospital scale has been established to identify posterior circulation LVO, including BAO. In the era when EVT has become the mainstay of LVO treatment, reduction of time from symptom onset to recanalization can improve the prognosis, which recently has been also reported in BAO [11–13]. In prehospital stroke management, convulsive-like symptoms may be an important indication of BAO, for which studies focusing on the clinical characteristics of BAO patients who developed these symptoms are required.

Herein, we outlined the clinical characteristics of BAO patients presenting with convulsive-like symptoms and underwent EVT at our stroke center. Additionally, we aimed to explore the key clinical features of these patients to propose better prehospital management of BAO.

## 2. Methods

The data that support the findings of this study are available from the corresponding author upon reasonable request.

### 2.1. Study design and settings

We conducted a single-center, retrospective case series study at Kobe City Medical Center General Hospital, a 760-bed tertiary referral hospital that has a comprehensive stroke center and an emergency department receiving approximately 35,000 patient visits and 10,000 ambulances per year. We designed a prehospital notification system, including a stroke hotline, to reduce the duration between the arrival of emergency medical services (EMS) and the initiation of tissue plasminogen activator (t-PA) administration or EVT. If the EMS providers suspect the patient is having stroke on the scene, they can immediately leave for the hospital by utilizing the hotline service. Moreover, with the information provided by the prehospital notification system, the medical staff in our hospital can prepare for the treatment of stroke, and two or more stroke physicians are available on arrival. In airway emergencies due to severe disturbance of consciousness, the emergency physician performs endotracheal intubation before EVT.

### 2.2. Study population

Among consecutive patients who underwent EVT for LVO during the 6-year period from April 1, 2015, to March 31, 2020, we included BAO patients. We excluded those whose symptoms from onset to EVT could not be ascertained, such as patients transferred from other hospitals. In addition, since our aim of this study was to examine the clinical significance of convulsive-like symptoms for the diagnosis of BAO in the prehospital setting, we excluded those who needed EVT due to worsening of symptoms after admission.

### 2.3. Convulsive-like symptoms

In this study, we defined convulsive-like symptoms as those encompassing abnormal motor symptoms that were documented as “convulsion,” “convulsive seizures,” or “convulsive-like movements” by EMS personnel or hospital medical staff including emergency physicians, nurses, and stroke physicians, between the stroke onset and the initiation of medical care in the emergency room.

### 2.4. Data collection

The clinical information was collected by reviewing the EMS run sheets and electronic medical records. The obtained data were patient demographics (age, sex, modified Rankin scale [mRS] score before onset [14], past diagnosis of epilepsy and stroke, and usage of stroke hotline);

findings on admission (neurological findings, vital signs, atrial fibrillation, semiology of convulsive-like symptoms, National Institute of Health Stroke Scale score [15], posterior circulation-acute stroke prognosis early computed tomography score (pc-ASPECTS) on diffusion-weighted imaging or non-contrast CT [16], occlusion site based on CT angiography or the first run of digital subtraction angiography in EVT [17]); treatment before EVT (antiepileptic drugs, tPA, and tracheal intubation); time metrics (time from onset to hospital arrival, time from hospital arrival to tPA administration and groin puncture, and time from groin puncture to recanalization); and clinical outcomes assessed by mRS at 90 days. The etiology of BAO was classified based on the Trial of Org 10,172 in the Acute Stroke Treatment classification system as large artery atherosclerosis, cardioembolism, small-vessel occlusion, stroke of other determined etiology, and stroke of undetermined etiology [18]. The operator provided the postprocedural modified Thrombolysis in Cerebral Infarction (mTICI) score; a score of 2b-3 indicated successful revascularization [19]. Functional outcome at 90 days was assessed using the mRS by contacting the patients or their relatives [20].

### 2.5. Ethics statements

This study was approved by the institutional review board of Kobe City Medical Center General Hospital (k200304). Written procedural consent was obtained from the patients or their healthcare proxy. The requirement for written informed consent was waived by the review board; instead, an opt-out method was adopted.

## 3. Results

There were 465 patients who underwent EVT within the specified period, of whom 44 (9.5%) had BAO. Three patients who had worsened symptoms after admission and 9 who were transferred from other hospitals were excluded. Among the remaining 32 patients, 7 (21.9%) had convulsive-like symptoms in the time between onset and the initiation of medical care in the emergency room.

Table 1 summarizes the clinical characteristics of the eligible patients. The median age was 72 (interquartile range [IQR], 69–78) years, and 6 of the 7 patients were men. None of them had a history of epilepsy or stroke, and 6 of the 7 patients had an mRS score of 0 before BAO onset. The prehospital stroke notification system was used in only 3 of the 7 cases. The semiology of convulsive-like symptoms was generalized in 6 of the 7 patients, and only 1 patient developed lateralized convulsion with conjugate deviation. No patient had anisocoria, and 3 of the 7 patients had positive Babinski's signs bilaterally. While 5 patients required intubation before EVT, 6 were administered t-PA. The median time from hospital arrival to t-PA administration was 55 (IQR, 33–106) min and that to groin puncture was 62 (IQR, 44–100) min. The time from hospital arrival to t-PA administration was short in the 3 patients who were transported after utilizing the prehospital notification system (Cases 1, 5, and 6).

BAO, basilar artery occlusion; mRS, modified Rankin scale; NIHSS, National Institute of Health Stroke Scale; pc-ASPECTS, posterior circulation-Acute Stroke Prognosis Early Computed Tomography Score; DWI, diffusion weighted imaging; TOAST, Trial of Org 10,172 in Acute Stroke Treatment; EVT, endovascular therapy; t-PA, tissue plasminogen activator; mTICI, modified Thrombolysis in Cerebral Infarction; NA, not available; LAA, large artery atherothrombosis; CE, cardioembolism; DZP, diazepam; fPHT, fos-phenytoin.

The summaries of two cases representative of this case series are provided below:

### 3.1. Case 1

A patient in their 70s with no significant previous medical history collapsed suddenly and experienced convulsions for several minutes. On arrival, the EMS providers recognized severe disturbance of

**Table 1**

Characteristics of patients with BAO who experienced convulsive-like symptoms during time between stroke onset and initial care

Case	1	2	3	4	5	6	7
<b>Baseline characteristics</b>							
Age	70s	60s	90s	70s	70s	40s	80s
mRS score before onset	0	0	0	0	0	0	3
Previous diagnosis of epilepsy	–	–	–	–	–	–	–
Previous diagnosis of stroke	–	–	–	–	–	–	–
Prehospital stroke notification	+	–	–	–	+	+	–
<b>Clinical symptoms</b>							
Glasgow Coma Scale score	6	3	6	7	4	7	6
Blood pressure, systolic/diastolic (mm Hg)	170/124	103/82	151/60	201/128	133/95	199/113	114/76
Atrial fibrillation	–	–	+	+	–	–	+
<b>Semiology of convulsive-like symptoms</b>							
Generalized/ Lateralized	Lateralized	Generalized	Generalized	Generalized	Generalized	Generalized	Generalized
Tonic/Clonic	Tonic	Clonic	NA	Clonic	Tonic	Tonic	Tonic-Clonic
Conjugate deviation	+	–	–	–	–	–	–
Pupil diameter	2/2	2.5/2.5	1.5/1.5	6/6	4/3	3/3	2/2
Pupillary light reflex	–/–	–/–	–/–	–/–	+/+	NA	+/+
Babinski's sign	NA	+/+	NA	NA	+/+	NA	+/+
NIHSS score	40	40	28	13	35	34	31
pc-ASPECTS	9 (CT)	6 (CT)	6 (DWI)	6 (CT)	5 (CT)	10 (CT)	7 (DWI)
Site of occlusion	Distal	Proximal	Middle	Distal	Middle	Distal	Distal
Stroke classification (TOAST)	LAA	undetermined	CE	CE	undetermined	undetermined	CE
<b>Treatment</b>							
Antiepileptic drugs before EVT	–	DZP, fPHT	DZP	DZP	–	–	DZP
Intubation before EVT	+	+	–	+	+	+	–
tPA administration	+	+	–	+	+	+	+
<b>Time metrics</b>							
Onset to hospital arrival (min)	34	188	77	56	33	33	44
Hospital arrival to t-PA administration (min)	33	200	NA	75	34	24	116
Hospital arrival to groin puncture (min)	41	206	101	47	36	62	98
Groin puncture to recanalization (min)	28	81	120	64	42	NA	41
<b>Clinical outcomes</b>							
Recurrent seizure after EVT	–	–	–	–	–	–	–
mTICI score after EVT	3	2b	2b	2b	3	0	2b
mRS score 90 days after onset	0	6	5	3	0	6	4

consciousness (GCS score, E1V1M1), tonic seizure of the left lower extremity, and conjugate eye deviation. The patient was transported to our hospital by contacting the stroke hotline 34 min after the onset. On arrival, the tonic movements have stopped; therefore, antiepileptic drugs were not administered. However, the patient was intubated 12 min after arrival because of failure to keep the airway open due to severe disturbance of consciousness. BAO was confirmed by computed tomography (CT) angiography; therefore, we initiated intravenous t-PA administration and EVT, 33 min and 41 min after arrival, respectively. After the procedure, the basilar artery was completely recanalized (mTICI score 3), and neurological symptoms improved dramatically. The patient was discharged with an mRS score of 0. The post-treatment magnetic resonance images revealed small infarcts in the right cerebellum and right thalamus. Presently, the patient is not taking any antiepileptic drugs, and the seizures have not occurred for a year.

### 3.2. Case 2

A patient in their 60s with a history of myocardial infarction and ventricular fibrillation was found unconscious. EMS providers observed that the patient had bilateral clonic convulsions and that the eye position was fixed at the midline. The patient was transported without using the stroke hotline to our hospital 188 min after the last time the patient was seen normal. On arrival, the emergency physician noted that the patient exhibited persistent severe disturbance of consciousness (GCS score, E1V1M1) and generalized clonic movements. Status epilepticus

was initially diagnosed; the patient was administered diazepam and fosphenytoin intravenously while tracheal intubation was performed. Non-contrast CT performed 47 min after arrival confirmed the absence of cerebral hemorrhage. The stroke team was consulted 110 min after arrival regarding the cause for the disturbance of consciousness. The stroke physician noticed positive Babinski's sign bilaterally; therefore, additional CT angiography was performed. After the diagnosis of BAO, t-PA administration and EVT were initiated 200 min and 206 min after arrival, respectively. Although recanalization of the basilar artery was successful (mTICI score 2b), the patient's symptoms did not improve and the patient died on day 6.

## 4. Discussion

Our study showed that convulsive-like symptoms were exhibited by approximately 20% of BAO patients who underwent EVT in the time between onset of stroke and initiation of emergency medical care. At the scene, less than half of the patients were suspected of having a stroke by the EMS providers. Patients who were transported without prehospital stroke notification or were initially treated for epileptic seizure tended to have longer time metrics.

Several cases of BAO accompanied by convulsive seizures as the initial symptom have been reported [4–8], however, this study is unique in that we examined the frequency of convulsive-like symptoms, including convulsive seizures and other convulsive-like movements, in consecutive BAO patients who underwent EVT. Pathophysiologically,

BAO suddenly causes posterior circulation ischemia, which can result in convulsive seizures by disrupting inhibitory projection from the cortex to the brain stem [2], as well as convulsive-like movements exhibited as pyramidal signs due to acute damage to the corticospinal tract [9]. We believe that our results highlight a clinically important issue because despite the observation of these convulsive-like symptoms in approximately 20% of BAO patients requiring EVT, they are not well recognized as typical symptoms of BAO. Indeed, EMS providers did not suspect stroke in more than half of the cases. Recent study has demonstrated that mechanical thrombectomy improves the functional outcome of BAO [21]. It has also been proved that shortening the time from onset to recanalization improves the functional outcomes [11–13]; therefore, there is a requirement for the development of an efficient prehospital management system to predict BAO.

We observed a high prevalence of convulsive-like symptoms among BAO patients but transporting all the patients with convulsive-like symptoms on the scene to a stroke center for suspected BAO may be an inefficient process, because convulsive-like symptoms may have other etiologies, such as epilepsy or systemic insults. To develop an efficient prehospital management system for BAO, understanding the differences in clinical characteristics of patients with convulsive-like symptoms due to BAO and those of patients with other conditions are crucial. From our results, convulsive-like symptoms and positive bilateral Babinski's sign may serve as clues for the early diagnosis of BAO. Our patients experienced convulsive-like symptoms for the first time in their lives at BAO onset, and these were often generalized. Unlike epileptic seizures in older people that are almost always focal [22], BAO is more likely to cause generalized symptoms because it disrupts the circulation of the basilar artery and posterior cerebral arteries bilaterally. In 3 of the patients in this study, positive bilateral Babinski's sign along with disturbance of consciousness was observed. If the lesion responsible for the seizure occurs in the brainstem [2], pyramidal signs seem to be more prevalent because the corticospinal tract runs along the ventral side of the brainstem, which is considered the area that is first affected in BAO. Considering these symptoms together, we believe that when an older patient with no previous history of stroke or epilepsy develops generalized convulsive-like symptoms with severe disturbance of consciousness or bilateral pyramidal signs, BAO should be considered.

This study has limitations. First, the number of cases is small; therefore, generalization of the results requires caution. Further studies with more cases are needed to improve the validity of our result. Second, the retrospective design might have caused measurement bias. Third, it is not possible to separate the types of convulsive-like symptoms or analyze the differences in clinical importance between them because electrophysiological evaluation was unavailable to classify them. Convulsive-like symptoms in our study may reflect various pathophysiological conditions because we documented a few select terms in the medical record, and it is also expected that there were differences in clinical assessment between observers. Fourth, there was a potential sampling bias; our case series study does not necessarily reflect the characteristics of all BAO cases because it was conducted at a single stroke center. We could not include patients with BAO who did not undergo EVT in this study. These patients were expected to have longer time from symptom onset to hospital arrival and might have different characteristic symptoms from the patients with BAO treated by EVT.

In conclusion, convulsive-like movements occurring in patients with BAO requiring EVT were not rare, and BAO should be considered when managing the first-time generalized convulsive-like symptoms occurring in older patients.

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None.

## CRedit authorship contribution statement

**Ryoma Inui:** Conceptualization, Data curation, Formal analysis, Project administration, Writing – original draft. **Satoru Fujiwara:** Conceptualization, Data curation, Formal analysis, Project administration, Writing – original draft. **Takehito Kuroda:** Data curation. **Nobuyuki Ohara:** Conceptualization, Data curation, Project administration, Writing – review & editing. **Hirotohi Imamura:** Data curation, Project administration, Writing – review & editing. **Nobuo Kohara:** Conceptualization, Supervision, Writing – review & editing. **Koichi Ariyoshi:** Data curation, Supervision. **Michi Kawamoto:** Conceptualization, Supervision, Writing – review & editing. **Nobuyuki Sakai:** Data curation, Project administration, Supervision, Writing – review & editing.

## Declaration of Competing Interest

Hirotohi Imamura received lecture fees from Stryker Japan K.K. and Medtronic Japan Co., Ltd.; Nobuyuki Sakai received lecture fees from Stryker Japan K.K., Medtronic Japan Co., Ltd., Daiichi Sankyo Company, Limited, Asahi Intecc Co., Ltd., and Biomedical Solutions, Inc.

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## References

- [1] I.E. Silverman, L. Restrepo, G.C. Mathews, Poststroke seizures, *Arch. Neurol.* 59 (2002) 195–201, <https://doi.org/10.1001/archneur.59.2.195>.
- [2] J.H. Cheng, Z. Zhang, Q. Ye, Z.S. Ye, N.G. Xia, Characteristics of the ischemic stroke patients whose seizures occur at stroke presentation at a single institution in eastern China, *J. Neurol. Sci.* 387 (2018) 46–50, <https://doi.org/10.1016/j.jns.2018.01.028>.
- [3] T.R. Meinel, J. Kaesmacher, P. Chaloulos-Iakovidis, L. Panos, P. Mordasini, P. J. Mosimann, et al., Mechanical thrombectomy for basilar artery occlusion: efficacy, outcomes, and futile recanalization in comparison with the anterior circulation, *J. Neurointerv. Surg.* 11 (2019) 1174–1180, <https://doi.org/10.1136/neurintsurg-2018-014516>.
- [4] A. Gadoth, H. Halleivi, Basilar artery occlusion presenting as a tonic-clonic seizure, *Isr. Med. Assoc. J.* 13 (2011) 314–315.
- [5] K. Matsuo, C. Fujii, I. Fuse, M. Nakajima, M. Takada, K. Miyata, Top of the basilar syndrome in a young adult initially presenting with a convulsive seizure, *Intern. Med.* 50 (2011) 1425–1428, <https://doi.org/10.2169/internalmedicine.50.4801>.
- [6] W.L. Conte, C.E. Gill, J. Biller, Top of the basilar syndrome presenting with convulsions, *JAMA Neurol.* 74 (2017) 248–249, <https://doi.org/10.1001/jamaneurol.2016.3449>.
- [7] E.C. Mader, V. Losada, J.C. Baity, E.M. McKinnies, L.A. Branch, Stroke-onset seizures during midbrain infarction in a patient with top of the basilar syndrome, *J. Investig. Med. High Impact Case Rep.* 8 (2020), <https://doi.org/10.1177/2324709620940497>, 2324709620940497.
- [8] S.K. Bhatt, S. Dawit, E.M. Okazaki, K.H. Noe, Refractory left focal motor status epilepticus as initial clinical presentation of acute basilar artery thrombosis, *Mayo Clin. Proc. Innov. Qual. Outcomes* 5 (2021) 511–515, <https://doi.org/10.1016/j.mayocpiqo.2020.12.002>.
- [9] G. Saposnik, L.R. Caplan, Convulsive-like movements in brainstem stroke, *Arch. Neurol.* 58 (2001) 654–657, <https://doi.org/10.1001/archneur.58.4.654>.
- [10] S.L. Demel, J.P. Broderick, Basilar occlusion syndromes: an update, *Neurohospitalist* 5 (2015) 142–150, <https://doi.org/10.1177/1941874415583847>.
- [11] M.D.I. Vergouwen, A. Algra, T. Pfefferkorn, C. Weimar, C.M. Rueckert, V. Thijs, et al., Time is brain(stem) in basilar artery occlusion, *Stroke* 43 (2012) 3003–3006, <https://doi.org/10.1161/STROKEAHA.112.666867>.
- [12] J. Uno, K. Kameda, R. Otsuji, N. Ren, S. Nagaoka, K. Maeda, et al., Mechanical thrombectomy for acute basilar artery occlusion in early therapeutic time window, *Cerebrovasc. Dis.* 44 (2017) 217–224, <https://doi.org/10.1159/000479939>.
- [13] H.F. Sang, J.J. Yuan, Z.M. Qiu, M. Zhang, X.G. Hu, W.H. Liu, et al., Association between time to endovascular therapy and outcomes in patients with acute basilar artery occlusion, *Neurology* 97 (2021) e2152–e2163, <https://doi.org/10.1212/WNL.0000000000012858>.
- [14] J.C. van Swieten, P.J. Koudstaal, M.C. Visser, H.J. Schouten, J. van Gijn, Interobserver agreement for the assessment of handicap in stroke patients, *Stroke* 19 (1988) 604–607, <https://doi.org/10.1161/01.str.19.5.604>.

- [15] P. Lyden, T. Brott, B. Tilley, K.M. Welch, E.J. Mascha, S. Levine, et al., Improved reliability of the NIH Stroke Scale using video training. NINDS TPA Stroke Study Group, *Stroke* 25 (1994) 2220–2226, <https://doi.org/10.1161/01.str.25.11.2220>.
- [16] G. Luo, D. Mo, X. Tong, D.S. Liebeskind, L. Song, N. Ma, et al., Factors associated with 90-day outcomes of patients with acute posterior circulation stroke treated by mechanical thrombectomy, *World. Neurosurg.* 109 (2018) e318–e328, <https://doi.org/10.1016/j.wneu.2017.09.171>.
- [17] F. Alemseged, D.G. Shah, M. Diomed, F. Sallustio, A. Bivard, G. Sharma, et al., The basilar artery on computed tomography angiography prognostic score for basilar artery occlusion, *Stroke* 48 (2017) 631–637, <https://doi.org/10.1161/STROKEAHA.116.015492>.
- [18] H.P. Adams, B.H. Bendixen, L.J. Kappelle, J. Biller, B.B. Love, D.L. Gordon, et al., Classification of subtype of acute ischemic stroke. Definitions for use in a multicenter clinical trial. TOAST. Trial of Org 10172 in Acute Stroke Treatment, *Stroke* 24 (1993) 35–41, <https://doi.org/10.1161/01.str.24.1.35>.
- [19] R.T. Higashida, A.J. Furlan, H. Roberts, T. Tomsick, B. Connors, J. Barr, et al., Trial design and reporting standards for intra-arterial cerebral thrombolysis for acute ischemic stroke, *Stroke* 34 (2003) e109–e137, <https://doi.org/10.1161/01.STR.0000082721.62796.09>.
- [20] L.C.M. Langezaal, E.J.R.J. van der Hoeven, F.J.A. Mont'Alverne, J.J.F. de Carvalho, F.O. Lima, Dippel DWJ, et al., Endovascular therapy for stroke due to basilar-artery occlusion, *N. Engl. J. Med.* 384 (2021) 1910–1920, <https://doi.org/10.1056/NEJMoa2030297>.
- [21] D.H. Kang, C. Jung, W. Yoon, S.K. Kim, B.H. Baek, J.T. Kim, et al., Endovascular thrombectomy for acute basilar artery occlusion: a multicenter retrospective observational study, *J. Am. Heart Assoc.* 7 (14) (2018), e009419, <https://doi.org/10.1161/JAHA.118.009419>.
- [22] A. Sen, N. Jette, M. Husain, J.W. Sander, Epilepsy in older people, *Lancet* 395 (2020) 735–748, [https://doi.org/10.1016/S0140-6736\(19\)33064-8](https://doi.org/10.1016/S0140-6736(19)33064-8).