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ORIGINAL COMMUNICATION

Predictors and outcome of status epilepticus in cerebral venous thrombosis

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Abstract

We report the clinico-radiological characteristics of SE in the patients with cerebral venous thrombosis (CVT), and compare the relative risk of SE in determining death and disability compared with those patients with and without self-limiting seizures. Consecutive patients with magnetic resonance venography (MRV) confirmed CVT, admitted during 2006–2017, were included. Their clinical details, risk factors, and magnetic resonance imaging and MRV findings were noted. Duration of SE, Status Epilepticus Severity Score (STESS), Glasgow Coma Scale score, and response to antiepileptic drugs were noted. 6-month outcomes were noted using the modified Rankin Scale. Of 153 CVT patients, 28 (18.3%) had SE, 62 (40.5%) self-limiting seizures, and 63 (41.2%) did not have seizures or SE. The SE group had a higher incidence of focal motor deficit (71.4% vs. 33%, $P=0.006$) and supratentorial lesions (93% vs 55.5%, $P=0.003$) than the no-seizure group. Multivariate analysis of SE and no-SE group (includes self-limiting and no seizure) did not indicate any significant predictor, but multivariate analysis of SE and no-seizure group indicated that supratentorial lesion only predicted SE (odds ratio 5.65, 95% confidence interval 1.11–28.76; $P=0.03$). Patients with SE and self-limiting seizure had similar clinical and MRI findings. In total, 17.8% had refractory SE; refractoriness was related to the pretreatment duration of SE ($P<0.001$). The death and disability were not significantly different between the three groups. At 6 months, 84% patients with SE, 92.3% with self-limiting seizure, and 94.8% in no-seizure group had good recovery.

Keywords Acute symptomatic seizure · Unprovoked seizure · Refractory status epilepticus · MRI · Death · Outcome

Introduction

Status epilepticus (SE) is a medical emergency, the outcome of which is related to the duration of SE and refractoriness to antiepileptic drugs. The annual incidence of SE in developed countries varies from 10.3 to 41 per 100,000 population, and is likely to be higher in developing countries owing to the prevalence of central nervous system infections [1–3]. In the SE cohort, arterial stroke has been reported as an etiology in 16.5%–60% patients [4–6]. Cerebral venous thrombosis (CVT) is a rare form of stroke and constitutes 0.5%–1% of all strokes [7]. However, in Southeast Asia, CVT is the leading cause of young stroke, and its incidence ranges from 22 to 117 per 1000 population [8, 9]. Up to 76% of CVT patients have seizures, particularly those with focal deficit and supratentorial parenchymal lesion anterior to central sulcus [3, 10–12]. Patients with CVT have often raised intracranial pressure, and the occurrence of seizures or SE in these patients may be life-threatening. The risk of acute symptomatic seizure is 2.7 times higher in haemorrhagic infarction compared to pale infarction. The mechanism of seizure in haemorrhagic lesion is not well understood [13]. Blood metabolites such as haemosiderin may cause focal cerebral irritation leading to seizure as reported in traumatic brain injury and in animal studies [14, 15]. In CVT, the presence of hemorrhagic infarction may result in refractory SE and poor outcome, but no study has assessed role of SE in the outcome of CVT. In this communication, we report the clinico-radiological characteristics of SE in patients with CVT, and compare the relative risk of SE in determining

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death and disability in CVT compared with those patients with and without self-limiting seizures.

Patients and methods

Between 2006 and 2017, consecutive patients with CVT were included. This is a retrospective study, and the data were analyzed from a prospectively maintained CVT and SE registry. The Institute Ethics Committee approved both these projects. Generalized convulsive SE was defined as two or more seizures without full recovery of consciousness in between or continuous convulsion and/or electrographic seizure activity lasting for more than 5 min. For focal convulsive SE with unconsciousness, the duration of seizure was more than 10 min [16]. Seizure or SE was categorized as acute symptomatic if occurred within the first 7 days of initial symptoms of CVT; while unprovoked seizure or SE was defined if seizure or SE occurred after 7 days [17].

The CVT presentation was considered acute if the patient was hospitalized within 2 days of symptoms, subacute if within 3–30 days, and chronic if after 30 days [1, 3]. The diagnosis of CVT was based on magnetic resonance venography (MRV). Patients with known epilepsy, psychiatric disease, pre-existing brain lesion, malignancy, and metabolic disorder or those on epileptogenic drugs were excluded.

Evaluation

Demographic information, duration of illness from the onset of first symptom, and presence of headache, seizure, focal neurological deficit; and alteration in sensorium were noted. Risk factors for CVT such as oral contraceptive use or pregnancy (female-specific) and genetic or secondary prothrombotic conditions were noted. The onset, type, and duration of SE and Status Epilepticus Severity Score (STESS) were noted. The Glasgow Coma Scale (GCS) score at admission was noted. The semiology and number of self-limiting seizures, and their response to antiepileptic drug were noted. Evidence of papilledema and cranial nerve palsy was recorded. Muscle power, tone, and reflexes were noted. Pinprick, touch, and joint position sensation, and cerebellar signs were examined once the patients were conscious and co-operative.

Investigations

Blood counts, hemoglobin level, coagulation profile, erythrocyte sedimentation rate, serum chemistry, HIV serology, chest radiograph, and electrocardiogram were carried out. The patients were investigated for prothrombotic conditions such as proteins C, protein S, and antithrombin III deficiency, factor V Leiden and *MTHFR* gene mutation, antinuclear antibody, anti dsDNA, antiphospholipid antibody, and lupus anticoagulant. Patients were also screened for paroxysmal nocturnal haemoglobinuria. Cranial magnetic resonance imaging (MRI) and MRV were performed using 3T machine (Signa GE, Medical System, Wisconsin, USA). Fast spin echo T2, T1, and diffusion-weighted sequences were obtained. The presence of parenchymal lesion, as well as its location, extent, and nature of abnormality were noted. Contrast MRV was performed, and location and extent of venous sinus thrombosis were noted.

Treatment

Patients with SE were treated with intravenous lorazepam (0.1 mg/kg) which was repeated if seizure was not controlled within 10 min. If seizure did not terminate even after the second dose of lorazepam, a second-line AED was administered, which included phenytoin [15 mg/kg intravenous (IV) at 50 mg/min], sodium valproate (30 mg/kg IV at 100 mg/min), levetiracetam (20 mg/kg IV at 100 mg/min), or lacosamide (400 mg at 60 mg/min) [18, 19]. Patients were considered to have refractory SE if they failed to respond to second-line AED, and in them, the other AEDs such as carbamazepine, clobazam, phenobarbitone, or lamotrigine was added. Burst suppression was not performed. Termination of convulsive SE was evaluated clinically, and EEG was performed only in those with prolonged unconsciousness without apparent cause. The duration of SE prior to initiation of AED in our hospital (pretreatment duration) and total duration of SE (pretreatment duration and the time taken to terminate SE after admission) were noted. We have not prescribed prophylactic AED. Patients with self-limiting seizure received levetiracetam (34), carbamazepine (16), sodium valproate (7), phenytoin (7), clobazam (6), oxcarbamazepine (2), or pregabalin (1) in isolation or in combination. Fifty-two patients received monotherapy and ten dual AEDs.

All patients received low-molecular-weight heparin (enoxaparin, 100 unit/kg subcutaneously twice daily) or unfractionated heparin 5000 IU intravenously followed by 18 unit/kg/h infusion to maintain activated partial thromboplastin time (APTT) at 2.5 times of control. Oral anticoagulant was prescribed after 15 days of heparin. Acetazolamide and/or mannitol were prescribed to those with raised intracranial pressure. Patients were intubated and mechanically ventilated if they had respiratory involvement with evidence of acidosis, hypoxia, or hypercarbia as determined on arterial blood gas analysis.

Outcome

Death during hospital stay and its causes were noted. Patients were followed up at 3 and 6 months, and outcomes were classified on the basis of modified Rankin Scale (mRS)

as poor (mRS > 2) or good recovery (mRS ≤ 2) [8]. The day of good recovery after discharge was also noted.

Statistical analysis

The underlying etiology, clinical characteristics, and MRI and MRV findings were compared among SE, self-limiting seizure, and no-seizure groups using the analysis of variance (ANOVA) or Chi-square test. Death and disability rates among the groups were also compared using the Chi-square test. The pretreatment duration of SE, GCS score, STESS, focal motor deficit, risk factors, MRI findings, and outcomes of patients with refractory SE were also compared with those without refractory SE using appropriate parametric and nonparametric tests. Multivariate analysis was used to determine the best predictors of SE after including variables having a *P* value of < 0.1 in the univariate analysis. Multivariate analysis was done between two groups; SE versus no-seizure group (excluding patients with self-limiting seizure) group and SE versus no-SE group (including self-limiting seizure and no-seizure in one group). Kaplan-Meier analysis was performed to evaluate death and disability at 6 months in the SE, seizure, and no-seizure groups. Cox regression analysis was used to derive the adjusted hazard ratio after adjusting the covariates that were significant in the univariate analysis. The statistical analysis was done using SPSS 16 version software (Statistical Package for Social Sciences, IBM, Chicago). A variable having a two-tailed *P* value of < 0.05 was considered significant.

Results

Hundred and fifty-three patients with CVT aged 3–76 years (median 29) were included, of whom 74 (43.4%) females. Ten patients (6.5%) had acute presentation (< 3 days), 123 (80.4%) had subacute presentation (3–30 days), and 20 (13.1%) had chronic presentation (> 30 days). Ninety (58.8%) patients had seizures, 28 of whom had SE and 62 had self-limiting seizure. In the SE group, 20 patients had SE within 7 days of illness and 8 after 7 days. Six patients had generalized convulsive, 21 focal motor with bilateral convulsive SE, and one had epilepsia partialis continua. In the self-limiting seizure group, 48 had seizure within 7 days of illness and 14 had after 7 days; of them, 24 had generalized convulsive, 27 focal motor with unconsciousness, and 11 had focal motor seizure. The number of self-limiting seizures ranged between 1 and 25 (median 2). The details are summarized in supplementary Table 1.

Status epilepticus group

The median age of patients with SE was 28 (range 16–60) years and 11 were females. Fourteen patients had SE at admission and another 14 developed SE during hospital stay. All had convulsive SE. The median pretreatment duration of SE was 8 min (5 min to 3 days). Their median STESS was 2.5 (range 1–3) and 14 (50%) patients had a favorable score. The risk factors for CVT were present in all except four patients. Twenty-six (93%) patients had parenchymal lesions, 22 of whom had hemorrhagic infarction. The infractions were cortical in 25 patients (frontal 15, temporal 5, parietal 13, and occipital 7) and subcortical in one patient (thalamic). Twenty-five (89.3%) patients had superficial venous system involvement (superior sagittal sinus—21, inferior sagittal sinus—1, and transverse sinus—14), and three (10.7%) patients had both superficial and deep system involvement (Fig. 1).

Status epilepticus was terminated after a single AED in 15 (53.6%) and after a second AED in eight (28.6%) patients. Five (17.9%) patients had refractory SE, and they received multiple AEDs. Patients who responded to first-line AED

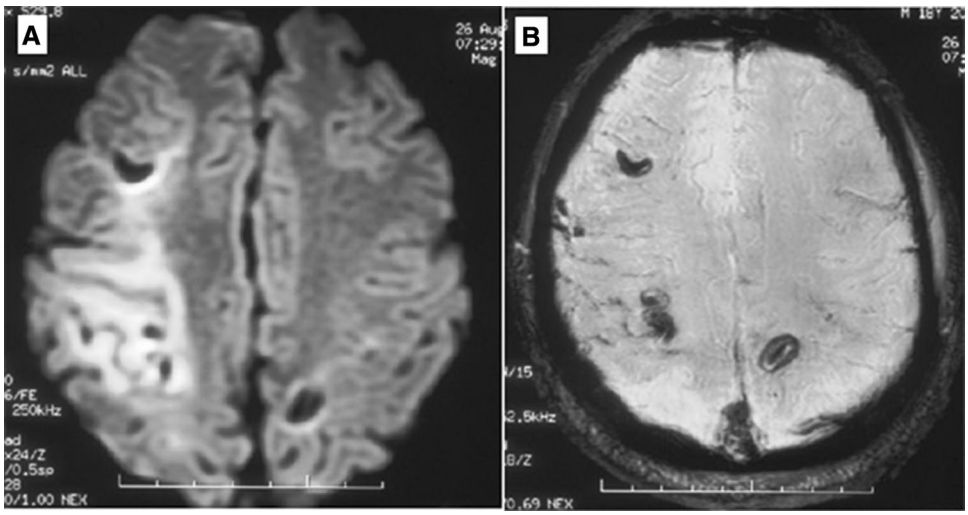

Fig. 1 **a, b**. Magnetic resonance imaging of an 18-year-old boy with cerebral venous thrombosis with refractory status epilepticus. **a** Axial sections, diffusion-weighted imaging, and **b** susceptibility-weighted sequence show hemorrhagic infarctions in the right frontal and left parietal regions. He had occlusions in both the superficial and deep cerebral venous systems (not shown). The patient recovered completely (mRS 0) at 3 months without breakthrough seizure

were subsequently prescribed levetiracetam, and those who responded to a second-line drug were prescribed clobazam in addition to their response AED. Details of refractory SE patients are presented in Table 1. Refractory SE patients had a longer pretreatment duration than the non-refractory group ($P < 0.01$). Duration of CVT, STESS score, MRI and MRV findings, underlying etiology, and outcome, however, were not different between the refractory and non-refractory SE groups (Table 2).

Comparison of SE, self-limiting seizure, and no-seizure groups

Sixty-two patients had self-limiting seizure and 63 did not have seizure. The SE and self-limiting seizure groups had higher frequencies of focal motor deficit and infarction on MRI compared to the no-seizure group. The GCS score was also lower in the SE group (11.21 ± 3.79 vs 13.14 ± 2.9; $P = 0.009$) and self-limiting seizure group (12.45 ± 3.64 vs 13.14 ± 2.9; $P = 0.24$) compared to the no-seizure group. The demographic, rapidity of symptoms, site of venous sinus thrombosis, and underlying risk factors, however, were not different between the three groups (Table 3). Multivariate analysis using dependent variable SE versus no-SE (included patients with self-limiting seizures and no seizure) indicated no significant variable. Multivariate analysis using dependent variable SE versus no-seizure, however, indicated that the presence of supratentorial lesion only predicted SE (odds ratio 5.65, 95% CI 1.11–28.76; $P = 0.03$) after adjustment for GCS score and focal motor deficit.

Outcome

Seventeen (11%) patients died in hospital: three (10.7%) having SE, nine (14.5%) having self-limiting seizure, and five (8%) without seizure. The in-hospital death rates were not significantly different amongst the three groups. One patient died after 2 months of discharge, and his exact cause of death could not be ascertained. The causes of in-hospital deaths were herniation in 14 and herniation with ongoing SE in three patients. At 6 months, 128 (83.7%) patients had good and eight (5.2%) had poor recovery. Kaplan–Meier analysis for death and disability at 6 months is shown in Fig. 2a, b. On Cox regression analysis, death (adjusted hazard ratio 1.06; 95% CI 0.35–3.30; $P = 0.91$) and disability (hazard ratio 1.07; 95% CI 0.72–1.60; $P = 0.75$) at 6 months were, however, not significantly different among the three groups after adjustment of GCS score, motor deficit, and parenchymal lesion.

Discussion

In the present study, 18.3% patients with CVT had SE, and 17.9% of whom had refractory SE. Supratentorial lesion was the independent predictor of SE when compared with no-seizure group. 11.7% patients with SE died, and 84% had complete recovery at 6 months, which were similar to those with self-limiting seizure and no-seizure groups. Although seizures are more common in CVT compared to other strokes, there are only a few case reports and comments on SE in the literature. We found nine case reports on SE due to CVT: three in female patients and two in children with hematological malignancy, and one child had nephrotic syndrome and the other protein S deficiency [20–26]. In a study on 76 patients with epilepsia partialis continua, three had CVT [27]. In another study on 90 patients with CVT, 42 had seizures; of them, 10 (11%) had SE. None of the SE patients died [3]. In contrast to this, Masuhr et al. reported higher deaths in those with SE

Table 1 Clinical, risk factors, MRI, and antiepileptic drugs in refractory status epilepticus (SE) in cerebral venous thrombosis (CVT)

Patient no.	1	2	3	4	5
Age (years)	18	32	45	38	26
Gender	Male	Male	Male	Male	Female
Duration of CVT (days)	7	21	2	60	30
Duration of SE	36 h	30 min	15 min	60 min	120 min
STESS	2	2	2	3	3
Risk factors	↑Homocysteine	MTHFR (CT), ↓ protein C	Idiopathic	Idiopathic	Prothrombotic (SLE)
MRV	SSS + cortical vein	SSS	SSS	SSS	SSS + cortical veins
MRI	Right frontal, bilateral parietal hemorrhagic infarct	Bilateral frontal hemorrhagic infarct (R > L)	Right parieto-occipital hemorrhagic infarct	Left frontal and corona radiate hemorrhagic infarct	Left frontal hemorrhagic infarct
AEDs	LOR + LEV + VPA + Clobazam	LOR + PTH + CBZ + LEV	LOR + LEV + Lacosamide + Clobazam	LOR + VPA + LEV + clobazam	LOR + LEV + PTH + Lacosamide
Death	No	No	No	No	No

AED antiepileptic drug, *CBZ* carbamazepine, *LEV* levetiracetam, *LOR* lorazepam, *MRI* magnetic resonance imaging, *MRV* MR venography, *PTH* phenytoin, *STESS* Status Epilepticus Severity Score, *SSS* superior sagittal sinus, *VPA* valproate

Table 2 Comparison clinical, risk factors, and radiological findings of cerebral venous thrombosis patients with refractory and non-refractory in status epilepticus

Parameters	Refractory (5)	Non-refractory (23)	*P* value
Age, years	31.80 ± 10.45	31.78 ± 14.77	1.00
Gender (females)	1	10	0.33
Duration of CVT	21 days (median)	10 days (median)	0.56
	Range—2–60 days	Range—1–120 days	
	IQR—4.5–45 days	IQR- 7–20 days	
Duration of SE before treatment	60 min (median)	7 min (median)	< 0.001
	Range—15–2160 min	Range—5–48 min	
	IQR—22.5–1140 min	IQR—7–20 min	
STESS	2.4 ± 0.54	2.47 ± 0.59	0.79
Parenchymal lesion	5 (100%)	21 (91%)	0.49
Types of lesion			
Infarct	0 (0%)	4/21 (19%)	0.29
Hemorrhagic infarct	5/5 (100%)	17/21 (81%)	
Location of infarct			
FT+	4 (80%)	13 (56.5%)	0.71
PO	1 (20%)	7 (30.4%)	
Others	0 (0%)	1 (4.3%)	
mRS at 6 months			
0–2	3 (60%)	18 (78.2%)	0.10
3–5	2 (40%)	2 (8.6%)	
6	0 (0%)	0 (0%)	
Death	0 (0%)	3 (13%)	0.07
Etiology			
Prothrombotic	3 (60%)	6 (26.1%)	0.06
Prothrombotic plus	0 (0%)	12 (52.2%)	
Idiopathic	2 (40%)	2 (8.7%)	
Infection	0 (0%)	3 (13.0%)	
Pregnancy	0 (0%)	0 (0%)	

FT Fronto temporal, *PO* Parieto-occipital, *STESS* Status Epilepticus Severity Score

(36.4%) compared to those with seizure (12%) [28]. None of the above-mentioned case reports and studies describes the details of treatment, refractoriness, and predictors of SE. The frequency of SE in ischemic and hemorrhagic stroke is rare. A nationwide inpatient sample for the years 1994–2002 in USA with a diagnosis of ischemic stroke or intracerebral hemorrhage revealed SE in 0.2% patients with ischemic stroke and 0.3% patients with intracerebral hemorrhage. Common predictors of SE in ischemic stroke and intracerebral hemorrhage were African-American ethnicity, renal disease, sodium imbalance, and alcohol abuse. Additional predictor in the ischemic stroke was hemorrhagic transformation and coagulopathy in intracerebral hemorrhage. Generalized tonic clonic SE was associated with poor outcome [29]. In a large study that evaluated SE using EEG, only 3% patients with NCSE were due to acute ischemic stroke [30]. Another study reported higher mortality rates among hospitalized elderly patients with SE compared to those with epilepsy; seven out of nine patients with SE died [31]. None of these studies on ischemic and hemorrhagic strokes reported response to AED and refractoriness.

In the present study, 75.5% patients had acute symptomatic seizure and 24.5% unprovoked seizure, which is quite higher than the reported frequency in ischemic or hemorrhagic stroke. In ischemic and hemorrhagic stroke, about 2.5%–6% patients have acute symptomatic seizure and 10–12% unprovoked seizure [32, 33]. In a study, 66 out of 2598 (2.5%) patients with ischemic stroke had acute symptomatic seizure, and diabetes, NIHSS score at admission, and cortical lesion were associated with seizure risk [33]. Rarity of seizure and SE has also been reported in a hospital based study on 714 patients with ischemic and hemorrhagic stroke. Forty-five (6.3%) patients only had acute symptomatic seizures; 4.2% with cerebral infarction and 16.2% with primary intracerebral hemorrhage. On multivariate analysis, intracerebral hemorrhage and hemorrhagic infarction had a higher risk of seizure compared to infarction. Seizure was commoner in cortical compared to subcortical lesion (9.8% vs 3.8%). Only 3

Table 3 Characteristics clinical, radiological, laboratory findings and outcome of patients with status epilepticus (SE), self-limiting seizure, and no-seizure groups

Parameters	SE [$N=28$ (A)]	Seizure [$N=62$ (B)]	No seizure [$n=63$ (C)]	P value (b/w groups)	P Avs B	P A vs C	P B vs C
Age (yrs)	31.79 ± 13.41	32.05 ± 12.8	34.27 ± 16.02	0.618			
Gender (females)	11 (39.3%)	30 (48.4%)	33 (52.4%)	0.514			
Illness duration							
< 3days	3 (11%)	5 (8%)	2 (3%)	0.239			
3–30 days	21 (75%)	51 (82%)	51 (80%)				
> 30 days	4 (14%)	6 (10%)	10 (16%)				
Motor deficit	20 (71.4%)	37 (59.6%)	21 (33%)	0.001	0.49	0.001	0.006
Admission GCS score	11.21 ± 3.79	12.45 ± 3.64	13.14 ± 2.9	0.045	0.14	0.009	0.24
Parenchyma lesion on MRI	26 (93%)	50 (80.6%)	35 (55.5%)	< 0.01	0.14	< 0.01	0.003
MRI type of lesion							
Infarct	4/26 (15.3%)	10/50 (20%)	11/35 (31.4%)	0.28			
Hemorrhagic infarct	22/26 (84.6%)	40/50 (80%)	24/35 (68.5%)				
Location of infarct							
Frontotemporal	17	38	15	0.01	0.60	0.10	0.002
Parieto-occipital	8	11	13				
Others	1	1	7				
MR venography							
Superficial	25 (89%)	52 (84%)	47 (74.6%)	0.100			
Deep	0	4 (6.4%)	4 (6.3%)				
Both	3 (11%)	6 (9.6%)	12 (19%)				
Death at discharge	3 (10.7%)	9 (14.5%)	5 (8%)	0.51			
mRS at 3 months							
0–2	21/25 (84%)	50/54 (92%)	54/58 (93%)	0.234			
3–5	4/25 (16%)	3/54 (5.5%)	4/58 (6.8%)				
6	0	1/54 (1.8%)	0				
mRS at 6 months							
0–2	23 (92%)	50/53 (94.3%)	55 (94.8%)	0.64			
3–5	2 (8%)	3 (5.7%)	3 (5.2%)				
6	0	0	0				
Etiology							
Prothrombotic	9	18	21	0.71			
Prothrombotic plus	12	28	23				
Idiopathic	4	10	15				
Infection	3	3	3				
pregnancy	0	3	1				

GCS Glasgow Coma Scale, *mRS* modified Rankin scale, *MRI* magnetic resonance imaging

out of 45 (6.7%) patients with seizure had SE [13]. Higher frequency of SE and seizure in our patients may be due to hemorrhagic cortical lesion in CVT compared to those thrombotic infarction and primary intracerebral hemorrhage, which are more frequently subcortical or ganglionic. Hemorrhagic lesions in cortical area are more seizurogenic both for acute symptomatic and post-stroke epilepsy. In animal study on traumatic brain injury, the severity of cortical damage was associated with spontaneous seizure discharge and a lowered seizure threshold [34].

Acute symptomatic SE is usually associated with a higher frequency of refractory and super refractory SE [29, 35, 36]. In a study on SE in viral encephalitis, 46.7% responded to the first-line AED and 36.7% were refractory to the second-line AED. About 30% patients died and death was not related to refractoriness of SE [36]. A systematic analysis of seizure in CVT has reported the incidence of acute symptomatic seizure in 6.9%–76%, and a supratentorial lesion especially in frontal or parietal area was associated seizure. Although some studies have shown higher mortality and

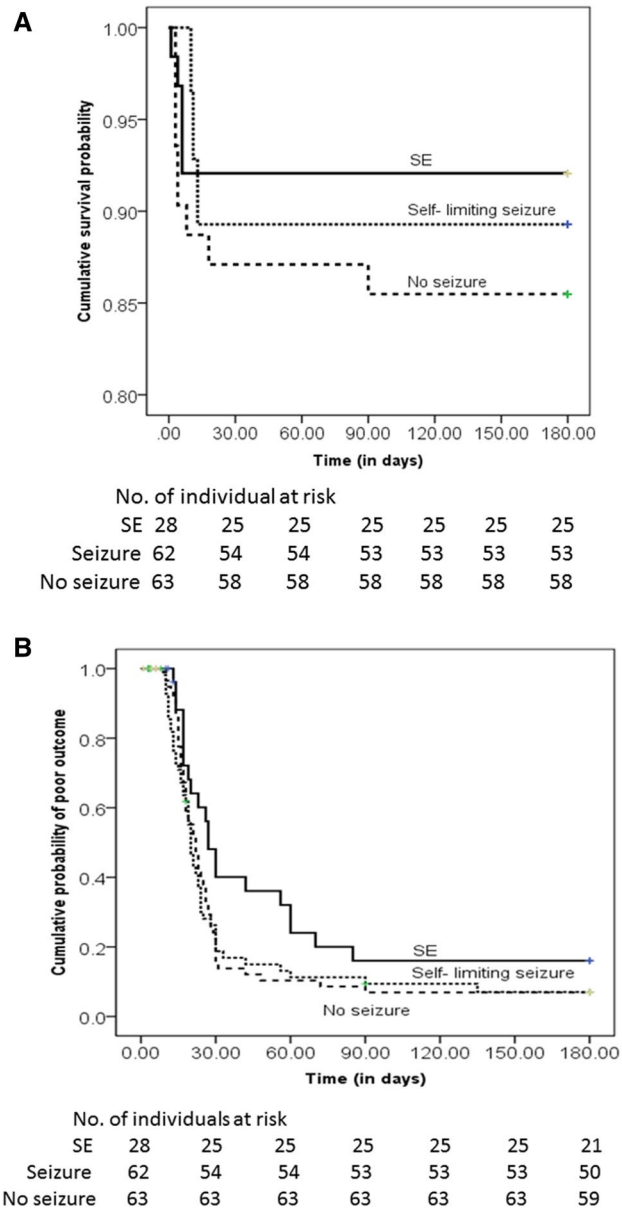

Fig. 2 **a** Kaplan–Meier curve shows cumulative probability of survival up to 6 months amongst the patients with status epilepticus (SE), self-limiting seizure, and no-seizure. The probabilities of survival were not different among the three groups. The chart below shows the number of surviving patients up to 6 months. **b** Kaplan–Meier survival curve shows cumulative probability of poor outcome up to 6 months among the patients with status epilepticus (SE), self-limiting seizure, and no-seizure group. The chart shows the number of individuals at risk

worse functional outcome, but the majority of studies did not find the association of seizure with death and disability [12]. In this systematic review, acute symptomatic seizure was defined if seizure occurred within 14 days. In our cohort, 84.4% of patients had self-limiting seizure or SE within 14 days of illness. The risk of death at 30 days in acute symptomatic seizure due to central nervous system infection, traumatic brain injury, and stroke was 8.9 times higher compared with those with unprovoked seizure [37]. In the present study, however, there was no difference in mortality and 6 month outcome in the patients with SE and self-limiting seizure compared to those without. The lesser refractoriness and better outcome of CVT patients with SE may be due to reversibility of tissue damage. Cerebral venous thrombosis results in venous congestion and stasis. Once the sinuses are recanalized, venous drainage improves and congestion and edema reduce, thereby restoring neuronal functions. In ischemic stroke or viral encephalitis, necrosis of neurons and glia occurs with greater oxidative stress and pro-inflammatory cytokines [38, 39]. Oxidative and mitochondrial stress markers are also lower in CVT compared to ischemic stroke [40].

The present study is limited by the heterogeneous AED protocol and the absence of long-term follow-up of breakthrough seizures in patients with SE compared to those without SE. One of the strengths of this study is the large number of SE patients from a single-center, they were evaluated extensively, and their treatment protocol was similar as two senior consultants (JK and UKM) managed them personally.

Conclusions

Status epilepticus occurs in about one-fifth patients with CVT, especially in those with supratentorial lesion. The presence of SE, however, does not determine the occurrence of death and disability in treated patients.

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Compliance with ethical standards

Conflicts of interest None of the authors has any conflict of interest.

Ethical statement We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines. Statistical analysis conducted by Dr. SK Mandal (Statistician of Centre for Biomedical Research at SGPGIMS, Lucknow, India).

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