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CLINICAL AND RADIOLOGICAL PROFILE OF POST-STROKE SEIZURES AND ASSOCIATED FACTORS IN A TERTIARY CARE HOSPITAL IN BANGLADESH

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ABSTRACT

Background: Post-stroke seizure (PSS) is an important neurological complication that negatively impacts recovery, functional outcome, and quality of life in stroke survivors. However, data on its clinical and radiological characteristics in Bangladesh remain limited. **Objective:** The primary objective of this study was to delineate the clinical presentation and seizure characteristics of patients who developed seizures following a stroke. In parallel, radiological correlates were examined, with particular attention to the influence of stroke type, lesion location, and individual patient-related factors on seizure occurrence. **Materials and Method:** Study place of this cross-sectional study was in the Department of Neurology at Dhaka Medical College Hospital from October 2023 to March 2025. A total of 100 adult patients with clinically and radiologically confirmed post-stroke seizures were enrolled using consecutive sampling. Structured questionnaires, clinical assessment, and neuroimaging was the data collection tools. Seizures classification was according to type and onset (early vs late). Associations were evaluated using the Chi-square ($\chi 2$) test, with $p<0.05$ considered statistically significant. **Results:** 57.93 ± 18 years was the mean age of the participants, with male predominance (60%). Hypertension (74%) was the most common comorbidity. Focal seizures were most frequent (39%), followed by generalized (32%) and focal to bilateral tonic–clonic seizures (29%). Early-onset seizures occurred in 62% of patients. Ischemic stroke was the most common subtype (57%), while cortical involvement was observed in 76% of cases, predominantly in the parieto-temporal region. Early-onset seizures were significantly associated with cortical lesions (72.4%), hemorrhagic stroke (81.1%), and venous stroke (100%) (p=0.001). Age (p=0.025), sex (p=0.001), and stroke type (p=0.001)were significantly associated with seizure type. **Conclusion:** Post-stroke seizures were predominantly early in onset and strongly associated with cortical involvement and hemorrhagic stroke. Stroke subtype and lesion location significantly influenced seizure characteristics, emphasizing the importance of early risk stratification and monitoring in high-risk patients.

Keywords: Post-stroke seizure, Cortical stroke, Hemorrhagic stroke, Early-onset seizure, Neuroimaging, Bangladesh

INTRODUCTION

Stroke represents one of the most significant health burdens globally.

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Clinically, it manifests as a rapidly evolving syndrome of focal or global cerebral dysfunction that either persists beyond 24 hours or proves fatal, arising exclusively from a vascular cause[1]. Globally, stroke stands as the second leading cause of death and a principal driver of long-term disability, with an estimated 15 million new cases recorded each year[2]. In low- and middle-income countries, including Bangladesh, the burden is particularly pronounced, with a reported prevalence of 11.39 per 1000 population[3]. Besides its direct clinical impact, stroke imposes substantial socioeconomic and psychological burdens on patients, caregivers, and healthcare systems.

As acute stroke management has advanced and survival rates have improved, growing attention has turned toward the post-stroke complications that impede recovery and compromise long-term patient outcomes. Among these, post-stroke seizure (PSS) represents a clinically significant neurological sequela with implications for morbidity, functional status, and quality of life[4]. The association between stroke and seizures has long been established since its initial description by Hughlings Jackson, yet it continues to pose diagnostic and therapeutic challenges in modern clinical practice[5]. The overall incidence of seizures following stroke is estimated at approximately 6.93%, although considerable variability exists across studies due to differences in study populations, methodologies, and definitions[6,7].

Post-stroke seizures encompass a heterogeneous group of clinical manifestations. As per 2017 International League Against Epilepsy (ILAE) classification, seizures may present as focal onset with or without impaired awareness, with or without motor features, or may evolve into bilateral tonic–clonic seizures; less commonly, generalized or unknown onset seizures may occur[8]. From a temporal perspective, PSS is broadly categorized into early seizures, typically occurring within the first two weeks of stroke, and late seizures, occurring thereafter[9]. This distinction is clinically relevant, as early seizures are primarily attributed to acute metabolic and biochemical disturbances, whereas late seizures are linked with structural reorganization and gliotic changes that predispose to epileptogenesis[10,11].

The conceptual distinction between post-stroke seizure and post-stroke epilepsy (PSE) remains an area of ongoing debate. While epilepsy has traditionally been defined as the occurrence of two or more unprovoked seizures separated by at least 24 hours, revised definitions now allow for diagnosis after a single seizure if the risk of recurrence exceeds 60% over the subsequent 10 years[12]. This evolving framework has introduced ambiguity in the classification of late-onset seizures following stroke, particularly given the wide variation in reported recurrence risks[13,14]. Consequently, inconsistencies in terminology continue to complicate interpretation and comparison across studies.

Advanced age, male sex, cortical involvement, larger lesion size, and anterior circulation infarction are the common risk factors for post-stroke seizures[9]. Additional factors such as hemorrhagic stroke, cerebral venous thrombosis, and stroke recurrence have also been implicated. Despite these insights, existing evidence remains heterogeneous, and the relative contribution of these factors to early versus late seizure development is not fully understood.The existing literature points to a predominance of focal onset seizures and a greater frequency of early-onset seizures, though considerable variability exists across study populations and findings are not uniformly consistent[11].

Importantly, the epidemiological and clinical characteristics of stroke vary across regions. In Bangladesh, a higher prevalence of cortical strokes, cardioembolic events, cerebral venous thrombosis, and younger stroke populations has been stated compared to many high-income settings[3]. These differences may impact both the incidence and clinical profile of post-stroke seizures. However, data from Bangladesh on this topic remain scarce, limiting the ability to develop context-specific clinical strategies and guidelines.

Given the clinical significance of post-stroke seizures and the existing gaps in regional evidence, a comprehensive evaluation of their clinical and radiological characteristics is warranted. Understanding the temporal pattern, seizure types, associated risk factors, and neuroimaging correlates is indispensable for improving early detection, guiding management, and predicting outcomes. Thus, the aim of this study is to investigate the clinical and radiological profile of post-stroke seizures, with particular emphasis on their association with stroke subtype, lesion location, and established risk factors.

MATERIALS AND METHOD

This study is hospital-based cross-sectional researchand was carried out in the Department of Neurology at Dhaka Medical College Hospital over an 18-month period from October 2023 to March 2025. Population were patients admitted with clinically and radiologically confirmed post-stroke seizures during the study period. Participants were recruited using a consecutive sampling approach, in which all patients fulfilling the predefined inclusion and exclusion criteria were systematically enrolled until the target sample size was reached.

For sample size estimation, the standard formula $n = \frac{z^2pq}{d^2}$ was used, considering a prevalence (p) of 6.93% based on previous literature(7), a 95% confidence interval (Z = 1.96), and a margin of error (d) of 0.05. Minimum sample size was 99.13 for this study, which was rounded to 100 for feasibility.

Dependent variables were defined as the presence, type, onset, and frequency of post-stroke seizures, whereas independent variables included patient age, sex, comorbid conditions, stroke type, and radiological characteristics. The study enrolled adult patients aged 18 years or above of either sex presenting with confirmed post-stroke seizures and providing informed written consent. Patients with a earlier history of epilepsy, metabolic disturbances (including hypocalcemia, hypomagnesemia, and uremia), sepsis, glycemic emergencies such as hyperosmolar hyperglycemic state or diabetic ketoacidosis, history of head injury, recurrent stroke, non-stroke-related neuroimaging findings, or those receiving medications known to precipitate seizures were excluded.

A structured and pre-tested questionnaire along with a written informed consent form was used for data collection. Ethical permission was secured from the Ethical Review Board of Dhaka Medical College Hospital (Memo No: ERC-DMC/ECC/2023/260), prior to study initiation. Detailed explanation of the study objectives, procedures, potential risks, and benefits were briefed before recruitingthe participants and written informed consent was obtained from the patient or their legal guardian.

Each participant went through a comprehensive clinical assessment, including detailed history taking and physical examination. The diagnosis of post-stroke seizure was established based on contemporary clinical definitions supported by neuroimaging findings. All enrolled patients underwent a standardized laboratory evaluation comprising complete blood count, fasting blood glucose, lipid profile, renal function tests, serum electrolytes, calcium, magnesium levels, urine routine examination, and a resting electrocardiogram.Neuroimaging was performed using a 128-slice computed tomography scanner or a 1.5 Tesla (or higher) magnetic resonance imaging system to evaluate stroke type, location, and extent.

Interviewer-administered questionnaires were utilized for sociodemographic and clinical data collection, with assistance from legal attendants where necessary, and recorded in standardized data collection forms. All data were checked for completeness, coded, and entered into IBM SPSS version 27 for analysis.

Continuous variables were expressed as mean ± standard deviation, whereas categorical data were presented as frequencies with corresponding percentages. Descriptive statistical analysiswas applied to characterize and summarize the clinical and radiological features of the study population.The Chi-square test was applied to evaluate associations between categorical variables, including demographic factors, stroke characteristics, and seizure profiles. A p-value of <0.05 was considered statistically significant.

Quality assurance was ensured through pre-testing of the data collection instruments, regular monitoring during data collection, and consultation with a statistician to maintain analytical rigor. Ethical principles were firmlyfollowed to throughout the study. Participation was voluntary, with the right to pull out at any stage without affecting treatment. Confidentiality was maintained by assigning unique identification numbers to each participant and restricting access to data to authorized personnel only.

Operationally, post-stroke seizure was defined as a seizure occurring after a stroke in a patient without a prior history of epilepsy. Early-onset seizures were defined as those happening within 2 weeks of stroke, while late-onset seizures were defined as those occurring after two weeks. Seizure classification and stroke categorization were based on established international clinical guidelines.

RESULTS

One hundred patients with post-stroke seizures were recruited for this study. The baseline sociodemographic, clinical, and stroke-related characteristics are presented in Table1. Most of patients were aged ≥45 years (77%), and a mean age of 57.93 ± 18 years. Male patients predominated (60%). Most common comorbidity was hypertension (74%), followed by dyslipidemia (29%), diabetes mellitus (27%), and coronary artery disease (25%). As far as stroke subtype concern, ischemic stroke was the most frequent (57%), followed by hemorrhagic (37%) and venous stroke (6%). Cortical involvement was observed in 76% of cases, while 24% had subcortical lesions. Among the seizure types observed, focal seizures were the most common type (39%), followed by generalized seizures (32%) and focal to bilateral tonic–clonic seizures (29%). The majority of patients (92%) experienced multiple seizure episodes, and status epilepticus was observed in 23% of cases.

Table 1: Baseline sociodemographic, clinical and stroke characteristics (n=100)

Variable	Category	n (%)
Age (years)	<45	23 (23.0)
	≥45	77 (77.0)
	Mean ± SD	57.93 ± 18.0
Sex	Male	60 (60.0)
	Female	40 (40.0)
Hypertension	Yes	74 (74.0)
Diabetes mellitus	Yes	27 (27.0)
Dyslipidemia	Yes	29 (29.0)
Coronary artery disease	Yes	25 (25.0)

Table 1 contiuned

Variable	Category	n (%)
Smoking status	Never smoker	44 (44.0)
	Current smoker	38 (38.0)
	Former smoker	18 (18.0)
Alcohol use	Yes	12 (12.0)
Stroke type	Ischemic	57 (57.0)
	Hemorrhagic	37 (37.0)
	Venous	6 (6.0)
Stroke location	Cortical	76 (76.0)
	Subcortical	24 (24.0)
Circulation	Anterior	54 (54.0)
	Posterior	3 (3.0)
Seizure type	Focal	39 (39.0)
	Focal to bilateral tonic–clonic	29 (29.0)
	Generalized	32 (32.0)
Seizure frequency	Single episode	8 (8.0)
	Multiple episodes	92 (92.0)
Status epilepticus	Yes	23 (23.0)

The temporal distribution of seizure onset is depicted in Figure 1. Early-onset seizures were more common, occurring in 62% of patients, while late-onset seizures accounted for 38%.

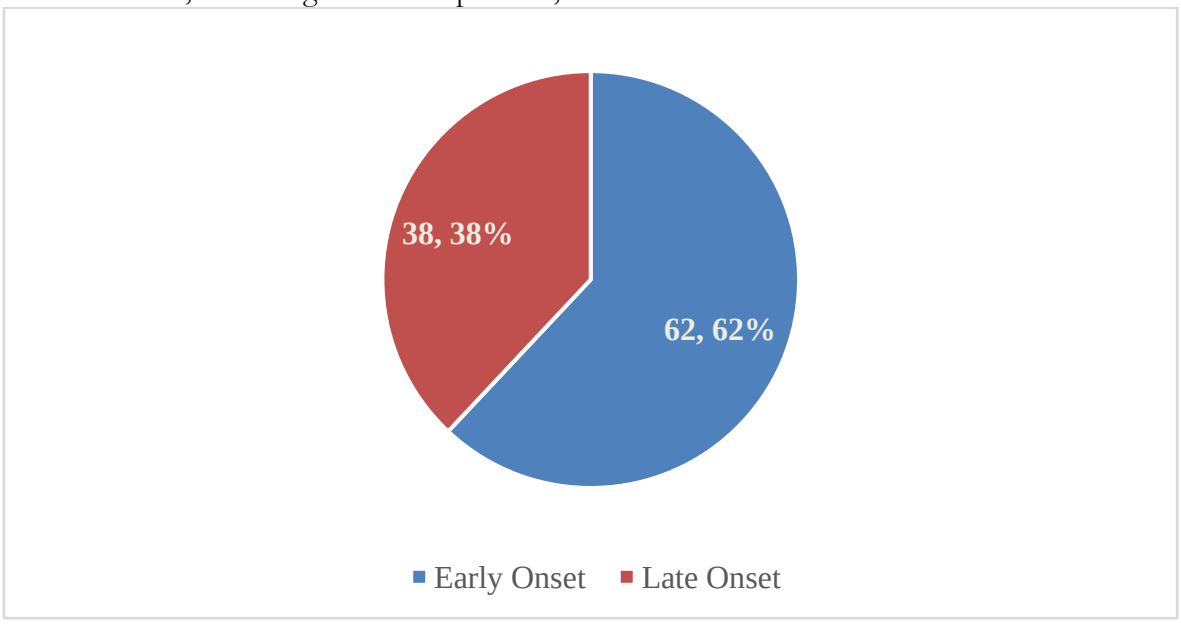

Figure 1: Distribution of Onset of Seizure

The semiological characteristics of post-stroke seizures are summarized in Table2. Among 56 patients with documented seizure semiology, aura was present in all cases, with a mean duration of 2.68 ± 1.8 minutes. Fear was the most frequently reported aura (24%), followed by tingling sensation (17%) and visual disturbances (11%). Oro-alimentary automatisms were observed in 6% of patients, while behavioral automatisms, particularly violent behavior, were common (24%). The mean ictal duration was 3.5 ± 1.6 minutes.

Table2: Distribution of Participants According to Semiology of Post-Stroke Seizure (n = 56)

Characteristics	Category	Frequency (n)	Percentage (%)
Aura Presence	Present	56	56
Aura Duration (minutes)	Mean ± SD	2.68 ± 1.8	—
Type of Aura	Rising epigastric sensation	4	4
	Dejavu	2	2
	Fear	24	24
	Tingling sensation	17	17
	Visual disturbance	11	11
Oro-alimentary Automatism	Present	6	6
Automatism	Verbal	10	10
	Mimicry	1	1
	Gestural	1	1
	Ambulatory	8	8
	Violent behavior	24	24
Duration of ictal events		3.5 ±1.6	

Post-ictal phenomena were observed in 80% of 88 evaluated patients, as shown in Table3. The mean post-ictal duration was 6.5 ± 5.4 minutes. Confusion was the most common post-ictal symptom (70%), followed by fear and anxiety (27%), vertigo (16%), sleep (11%), urinary or bowel urgency (10%), and nausea or vomiting (7%).

Table 3: Post-ictal features in post-stroke seizures (n=88)

Variable	Category	n (%)
Post-ictal state present	Yes	80 (80.0)
Duration (min)	Mean ± SD	6.5 ± 5.4
Post-ictal confusion	Yes	70 (70.0)
Fear/anxiety	Yes	27 (27.0)
Vertigo	Yes	16 (16.0)
Urinary/bowel urgency	Yes	10 (10.0)
Sleep	Yes	11 (11.0)
Nausea/vomiting	Yes	7 (7.0)

Radiological findings revealed that cortical involvement was predominant (76%), as presented in Table 4. Among cortical lesions, the distribution of lobar involvement is detailed in Table 4, where the parieto-temporal area was most frequently impacted (55.3%), followed by fronto-parietal (31.6%), temporo-occipital (23.7%), and parieto-occipital regions (15.8%).

Table 4: Radiological distribution of cortical involvement (n=76)

Lobar Involvement	Frequency (n)	Percentage (%)
Fronto-parietal	24	31.6
Parieto-temporal	42	55.3
Temporo-occipital	18	23.7
Parieto-occipital	12	15.8

Gyral-level analysis revealed the superior temporal gyrus as the most frequently involved region, identified in 33 cases. The inferior frontal gyrus and precentral gyrus followed, affected in 30 and 28 cases respectively. Moderate involvement was documented in the postcentral gyrus (22 cases), middle temporal gyrus (21 cases), and middle frontal gyrus (19 cases), whereas the parahippocampal gyrus demonstrated only minimal pathological involvement (Figure 2).

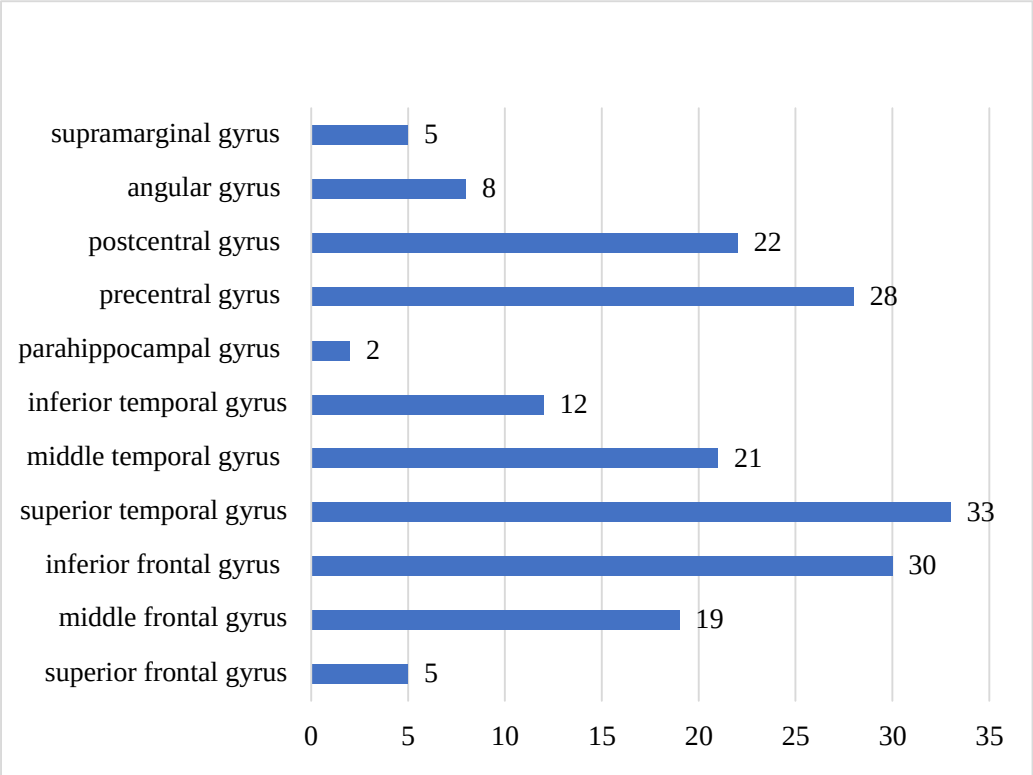

Figure 2: Distribution of gyrus involvement

The association between clinical variables and seizure onset is shown in Table5. No significant association was found between seizure onset and age (p=0.225) or sex (p=1.000). However, stroke location and stroke type were significantly associated with seizure onset. Cortical strokes were significantly associated with early-onset seizures (72.4%), whereas subcortical strokes were more commonly associated with late-onset seizures (70.8%) (p=0.001). Similarly, hemorrhagic stroke (81.1%) and venous stroke (100%) were strongly associated with early-onset seizures, while ischemic stroke was more frequently associated with late-onset seizures (54.5%) (p=0.001).

Table 5: Factors Associated with Onset of Seizure (n = 100)

Characteristics		Onset of Seizure		p-value
		Early Onset (n, %)	Late Onset (n, %)	
Age (years)	<45	17 (73.9)	6 (26.1)	
	≥45	45 (58.4)	32 (41.6)	0.225
Sex	Male	37 (61.7)	23 (38.3)	
	Female	25 (62.5)	15 (37.5)	1.0
Location of Stroke	Cortical	55 (72.4)	21 (27.6)	
	Subcortical	7 (29.2)	17 (70.8)	0.001
Type of Stroke	Ischemic	26 (45.6)	31 (54.5)	
	Hemorrhagic	30 (81.1)	7 (18.9)	
	Venous	6 (100.0)	0 (0.0)	0.001

As depicted in Table 6, seizure type demonstrated significant associations with several clinical parameters. Among demographic variables, both age (p=0.025) and sex (p=0.001) were significantly linked to seizure type. Generalized seizures were more characteristic of younger patients under 45 years (52.2%) and female patients (55.0%), while focal seizures were more commonly encountered in older patients aged 45 years or above (45.5%) and in males (50.0%). With respect to stroke characteristics, stroke type was significantly associated with seizure type (p=0.001). Focal seizures predominated in ischemic stroke (50.9%), while generalized seizures were more frequent in both hemorrhagic (45.9%) and venous stroke (83.3%). Stroke location and seizure onset, however, did not reach statistical significance (p=0.802 and p=0.174, respectively).

Table 6: Factors associated with Seizure Type Among Post-Stroke Patients (n = 100))

Characteristics		Type of Seizure			*p*-value
		Focal (n, %)	Focal to Bilateral (n, %)	Generalized (n, %)	
Age (years)	<45	4 (17.4)	7 (30.4)	12 (52.2)	
	≥45	35 (45.5)	22 (28.6)	20 (26.0)	0.025
Sex	Male	30 (50.0)	20 (33.3)	10 (16.7)	
	Female	9 (22.5)	9 (22.5)	22 (55.0)	0.001
Location of Stroke	Cortical	30 (39.5)	23 (30.3)	23 (30.3)	
	Subcortical	9 (37.5)	6 (25.0)	9 (37.5)	0.802
Type of Stroke	Ischemic	29 (50.9)	18 (31.6)	10 (17.5)	
	Hemorrhagic	10 (27.0)	10 (27.0)	17 (45.9)	
	Venous	0 (0.0)	1 (16.7)	5 (83.3)	0.001
Onset of Seizure	Early	21 (33.9)	17 (27.4)	24 (38.7)	
	Late	18 (47.4)	12 (31.6)	8 (21.1)	0.174

DISCUSSION

This study provides a thorough evaluation of the clinical and radiological characteristics of post-stroke seizures and their association with stroke type, location, and patient demographics. The findings highlight a predominance of older patients, a higher burden among males, and a strong association of seizure patterns with stroke pathology and cortical involvement.

Majority of the patients were aged ≥45 years, and a mean age of 57.9 years, reflecting the established epidemiology of stroke and its complications. The male predominance observed in this study comparable with existing evidence, which attributes the higher incidence of stroke and its subsequent complications in men to a combination of biological and behavioral risk factors[13,15–17]. The high prevalence of hypertension, dyslipidemia, diabetes mellitus, and smoking further highlights the pivotal role of vascular risk factors in the development of post-stroke seizures (18–20). Therefore, evidence indicating that cardiovascular comorbidities contribute not only to the occurrence of stroke but also to heightened neuronal vulnerability and the process of epileptogenesis[15,17].

Early-onset seizures were more common than late-onset seizures, accounting for nearly two-thirds of cases. This pattern supports the concept that early seizures are primarily driven by acute pathophysiological processes, including ionic imbalance, excitotoxicity, and inflammatory responses following cerebral injury[15,21]. Late-onset seizures, by contrast, are believed to result from long-term structural reorganization and gliosis[21]. The high proportion of patients experiencing multiple seizure episodes further indicates that post-stroke seizures often follow a recurrent course[13,17]. Notably, the relatively high frequency of status epilepticus observed in this study suggests a substantial burden of severe seizure manifestations, although earlier studies have reported lower prevalence rates[16,21].

The most common seizure type was focal seizures, although a considerable proportion of patients presented with generalized and focal-to-bilateral tonic–clonic seizures. This distribution suggests heterogeneity in seizure propagation patterns following stroke. The predominance of focal seizures is consistent with the localized nature of cortical injury, whereas generalized seizures may reflect secondary generalization or involvement of widespread cortical networks[16]. However, some studies have mentioned a higher prevalence of generalized seizures, indicating variability across populations[21].

Stroke characteristics demonstrated strong associations with seizure onset and type. Hemorrhagic and venous strokes were significantly associated with early-onset seizures, while ischemic strokes were more frequently linked to late-onset seizures. These findings are biologically plausible, as hemorrhagic lesions expose cortical tissue to blood products, which are highly epileptogenic, whereas ischemic injury may lead to delayed neuronal reorganization and epileptogenesis[15,17,19,21,22]. Furthermore, cortical strokes were strongly associated with early-onset seizures, whereas subcortical lesions were more frequently associated with late-onset seizures, reinforcing the critical role of cortical involvement in seizure generation[13,20,23].

Associations of age, sex, and stroke type with seizure types found significant. Younger patients were tended to experience generalized seizures, whereas older individuals predominantly exhibited focal seizures. Similarly, females exhibited a higher proportion of generalized seizures, while males more commonly had focal seizures. These findings might indicate variations in neuronal plasticity, hormonal effects, and cortical excitability related to age and sex, even though some research has shown no notable association[19,20,22]. Stroke type also significantly influenced seizure phenotype, with ischemic strokes more commonly linked with focal seizures and hemorrhagic and venous strokes with generalized seizures, highlighting the role of underlying pathology in shaping seizure characteristics[15].

Semiological analysis further supported the predominance of cortical involvement. Aura was reported in a substantial proportion of patients, with fear, tingling sensations, and visual disturbances being the most common manifestations, suggesting involvement of temporal, parietal, and occipital regions. The presence of automatisms, particularly behavioral and verbal forms, reinforces the role of temporal and frontal lobe networks in seizure generation[12]. Post-ictal phenomena were also frequent, with confusion being the most common symptom, reflecting transient global cerebral dysfunction following seizure activity.

Analysis of neuroanatomical distribution revealed the parieto-temporal region as the most frequently implicated territory, with substantial additional involvement of the frontal and temporo-occipital regions. At the gyral level, the superior temporal, inferior frontal, and precentral gyri were most commonly affected, indicating that seizures predominantly originate from or propagate through functionally active cortical areas involved in sensory, motor, and integrative processing. Minimal involvement of limbic-associated regions such as the parahippocampal gyrus suggests that seizure activity in post-stroke patients is more closely related to cortical rather than deep structural pathology.

These findings have important implications in clinical perspective. Patients with cortical and hemorrhagic strokes represent a high-risk group for early-onset seizures and may benefit from closer neurological monitoring and timely intervention. The identification of specific seizure patterns and associated risk factors can assist clinicians in early diagnosis, risk stratification, and individualized management. In selected high-risk patients, consideration of prophylactic antiepileptic therapy may be warranted, although further evidence is needed to guide such practices[15,17].

LIMITATIONS AND RECOMMENDATIONS

The current study has numerous limitations that need to be acknowledged when analyzing the results. The single-center approach and comparatively inadequate sample size might constrain the applicability of the findings. Additionally, the cross-sectional nature of the study does not allow for the assessment of long-term outcomes, seizure recurrence patterns, and treatment responses. The absence of complete electroencephalographic data and longitudinal follow-up across all patients may have constrained the comprehensive characterization of seizure types. Validation of the present findings through multicenter prospective studies incorporating larger cohorts and extended follow-up periods is therefore needed. Incorporating advanced neuroimaging and electrophysiological assessments may further elucidate the mechanisms of post-stroke epileptogenesis. Developing risk stratification models for early identification of high-risk patients could support targeted preventive and therapeutic strategies and improve clinical outcomes.

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CONFLICT OF INTEREST

There is no conflict of interest.

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