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ORIGINAL ARTICLE

Incidence and Association of Seizures in Stroke Patients Undergoing Endovascular Therapies

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ABSTRACT

Background: Endovascular therapies have revolutionized the treatment of stroke, but post-stroke seizures continued as significant complication that impacted morbidity.

Objectives: We examined the incidence and association of seizures in stroke patients undergoing endovascular therapy (EVT).

Methods: Investigation included 384 hospitalized patients with acute ischemic or hemorrhagic stroke undergoing EVT. To distinguish and investigate the stroke, and to identify subtypes of stroke using the TOAST classification, the incidence of seizures was determined in stroke patients following EVT through brain imaging.

Results: We analyzed the demographic and clinical characteristics of 384 stroke patients who underwent EVT and had seizures. Seizures were found to occur in 6.51% of EVT patients ($p>0.05$). Occurrence of seizures was non-substantially affected by comorbidities like hypertension, cardiac maladies and diabetes. Majority of stroke patients (82.81%) suffered from ischemic strokes, while only 17.18% had hemorrhagic strokes. Large artery atherosclerosis was the most prevalent subtype of stroke associated with seizures following EVT. The severity of the stroke and existing of cortical involvement were not significantly associated with seizures ($p<0.05$), whereas lower age and early seizures after EVT were associated with a marginally increased risk of experiencing seizures. Overall, study indicated that incidence of seizures following EVT was relatively low and influenced by particular factors.

Practical implication: This study emphasized the need for personalized patient care strategies, including vigilant surveillance for seizures and preventative interventions, to enhance the outcomes of stroke patients undergoing endovascular therapy.

Conclusion: Seizures are a significant complication of EVT for stroke patients. Stroke severity and etiology may influence seizure risk, highlighting the significance of vigilant monitoring and proactive management to reduce the incidence of seizures in this patient population.

Keywords: Endovascular treatment; Epidemiology; Epilepsy; Hemorrhage; Seizures; Thrombectomy.

INTRODUCTION

Stroke served one of the primary causes of morbidity and mortality and continues as prevalent global health concern. According to World Health Organization, 2nd leading cause of death and 3rd leading cause of disability throughout the globe is stroke [1-2]. Devastation of a stroke extends beyond the initial event, as survivors frequently encounter post-stroke complications that bear significant impact on their life quality. The advent of seizures following a stroke is a critical complication that can exacerbate the disease burden [3-4].

Endovascular therapies, such as mechanical thrombectomy and coiling, have revolutionized the treatment of acute ischemic and hemorrhagic strokes, in particular [5]. These inventive techniques have significantly contributed to the reduction of long-term disabilities and improvement of stroke patient survival rate. Despite these advancements, the post-procedure phase still presents obstacles [6]. Among these, post-stroke convulsion presents a challenging clinical scenario that necessitates careful consideration [7-9].

Seizures following the stroke were stated early or late, dependent on whether they occur within seven days of stroke or later. Their incidence differs considerably and is related to variables such as stroke type, stroke severity, and patient characteristics [3, 10]. Intriguingly, research suggests that incidence of post-stroke seizures may be higher in patients who have undergone endovascular therapy, thus raising pertinent concerns about this association [11].

Despite the fact that endovascular treatments have significantly improved stroke outcomes, the incidence of seizures following such procedures remains a major cause for concern [4, 12]. Existing literature provides a wide range of seizure incidence following a stroke, ranging from 3% to 33%, indicating a lack of precise comprehension of this complication [13]. The influence of endovascular treatments on the risk of convulsions is not completely understood, with contradictory findings in the current literature. In addition, the specific factors that influence the risk of epileptic seizures following endovascular treatments remain unclear [14].

Therefore, we conducted this epidemiology investigation to address these knowledge gaps regarding incidence of seizures in stroke patients who have undergone endovascular therapy, to identify the risk factors linked to development of post-stroke seizures, focusing on stroke type (hemorrhagic or ischemic), stroke location, stroke severity, and patient age and to assess its effects on patient outcomes following endovascular therapy.

MATERIAL AND METHODS

This observational study was conducted in the Department of Neurology at the Mardan Medical Complex in Mardan, Khyber Pakhtunkhwa. The research was conducted between April 2020 and April 2023. Participants were recruited prospectively in a non-random manner, comprising 384 patients (calculated using WHO samples size calculator keeping 50% proportion size at 95% confidence interval and 2 degree of freedom) presented at the emergency care department. This research examined incidence and associations of seizures in stroke patients receiving endovascular therapy.

Patients admitted with an acute ischemic or hemorrhagic stroke and receiving endovascular therapy of different sex and age over 18 years were enrolled in the study. Patients having seizures, other serious neurological conditions, or an allergy to the contrast agents used in endovascular treatment were excluded from the study. The study also excluded participants with a pre-existing epilepsy diagnosis or metabolic disturbances such as sepsis and electrolyte imbalance [15-16].

Demographic information, medical history, details about the stroke (type, location, severity), and endovascular treatment specifics were recorded for study patients. Patients were

monitored for the occurrence of seizures following the procedure. The seizures were classified as 'early' (within seven days of the stroke) or 'late' (after seven days). On the basis of clinical observations and, electroencephalogram (EEG) findings, seizures were identified and confirmed [17].

Brain imaging, specifically CT or MRI, were performed to distinguish between ischemic stroke (IS) and intracerebral hemorrhage and to identify subtypes of stroke. IS subtypes were classified according to the TOAST [18].

TOAST, (Trial of Org 10172 in Acute Stroke Treatment), is a classification system for subtypes of ischemic stroke that was created to serve as a standard method for classifying subtypes of stroke based on etiological categories, thereby facilitating research on stroke and its causes. It divides stroke into five subtypes:

1. Large artery atherosclerosis: Strokes caused by atherosclerotic plaques in the principal arteries of brain.
2. Cardioembolism: Strokes resulting from heart-originating embolic particles.
3. Small vessel occlusion: Strokes resulting from occlusion of small penetrating arteries perfusing the deep structures of the brain. This results in lacunes or minor infarcts.
4. Stroke of other determined etiology: Strokes with a specific, identified cause other than atherosclerosis of the large arteries, cardioembolism, and small vessel occlusion. This may include arterial dissection, specific hematological disorders, or vasculopathies.
5. Stroke of undetermined etiology:Strokes for which the cause remains unidentified despite extensive investigation, or for which two or more potential causes are identified but the most likely cause cannot be determined.

Seizures were presented alongside patient characteristics using descriptive statistics. Using Chi square and ANOVA tests, associations between the occurrence of seizures and potential risk factors were evaluated. At $p<0.05$, results were deemed statistically significant. Statistical software (SPSS 23.0) was employed for all analyses.

All procedures performed in studies involved human participants and were adhered to the ethical standards of institution's and research committees, along with 1964 Helsinki declaration. Institutional review boards at each participating center granted ethical sanction for the study. Patients' privacy was protected, and data was anonymized for analysis purposes.

RESULTS

Demographic and clinical characteristics of stroke patients suffering from seizures following endovascular treatment of 384 patients indicated that 25 (6.51%) patients were experiencing seizures after EVT ($p<0.05$). Mean age of patients was 56.42+8.19 and 54.91+8.8 without and with seizures, respectively. Seizures were encountered by 6.95% of male patients versus 5.85% of female patients, Comorbidities like hypertension, previous cardiac conditions, and diabetes, revealed that there was no statistically significant difference in the incidence of seizures ($p>0.05$) between patients with these comorbidities and those without (Table 1).

Incidence of seizures in patients who underwent EVT for treating the stroke occurred in 25 of the 384 (6.51%) stroke patients. After EVT, odds ratio (OR) for experiencing a seizure was 1.2046. The OR is marginally greater than 1, indicating a minor increase in the likelihood of experiencing a seizure after EVT, although the difference is minimal. The confidence interval (CI) for the odds ratio ranges from 0.5182 (lower limit) to 2.7998 (upper limit), with a 95% level of confidence, indicating that we have a 95% assurance that the true odds ratio fell within this range. The analysis yielded p-value of 0.6654, indicating that difference in incidence of seizures ($p>0.05$) following EVT was not significant (Table 2).

Incidence of ischemic and hemorrhagic strokes among 384 stroke patients included showed that preponderance of these patients, 318 (82.81%), were determined to have suffered ischemic strokes. In contrast, only 66 (17.18%) suffered from hemorrhagic strokes. At 0.00001, the p-value measured the probability that the observed differences occurred by coincidence, was extremely low. The difference between the incidence of ischemic and hemorrhagic strokes in this patient population was hence statistically significant ($p<0.05$). In other words, ischemic stroke is substantially more prevalent than hemorrhagic stroke among these stroke patients (Table 3).

The breakdown of stroke subtypes determined by TOAST classification among patients who experienced convulsions following EVT represented that large artery atherosclerosis was the most prevalent subtype of stroke with 181 instances while, stroke of other determined etiology was the least prevalent subtype among patients who did not experience seizures, with only five instances. Similarly, patients experiencing seizures, stroke of other determined etiology and cardioembolism tied for the position of being the least prevalent, with each accounting for 2 cases. This suggested that patients with large artery atherosclerosis were more susceptible to seizures after EVT (Figure 1).

Relationship between various risk factors and occurrence of seizures in patients who underwent EVT for stroke were represented in odds ratios (ORs) and respective 95% confidence intervals (CIs) for their quantification. With an OR of 0.3976 and 95% CI ranging from 0.1639 to 0.9642, the severity of stroke indicated that likelihood of experiencing convulsions after EVT decreased as stroke severity increased ($p<0.05$). ORs of 0.8285 for hemorrhagic stroke indicated a lower likelihood of seizures following EVT compared to ischemic stroke. The OR for cortical involvement was 0.2029. The p-value of 0.1577 indicated that connection between cortical involvement and occurrence of seizures was not statistically significant ($p>0.05$). Patients younger in age had relative risk (OR) of 1.2692, indicating a greater likelihood of experiencing seizures ($p>0.05$). Lastly, early seizures after EVT were strongly associated with OR of 2.5838, indicating that the likelihood of seizures was greater than doubled ($p>0.05$) (Table 4).

Table 1: Demographic features of the stroke patients

S. No	Demographic variable	Patients without seizures n(%)	Patients with seizures n(%)	$\chi 2$	p-value
1	Number of patients n(%)	359 (93.49)	25 (6.51)	209.5529	0.00001*
2	Age (Mean+SD) years	56.42+8.19	54.91+8.67	0.008	0.9954
	Sex n(%) Male Female	 214 (93.05) 145 (94.15)	 16 (6.95) 9 (5.85)	0.0493	0.8243
3	Smoking (n) Yes No	 114 245	 08 17	0.0387	0.8440
4	Comorbidities (n) Hypertension Previous cardiac ailments Diabetes mellitus	 226 25 97	 16 02 07	0.0248	0.9876

*indicated that the value is significant at $p<0.05$

Table 2: Incidence of seizures in stroke patients after EVT

No. of stroke patients who underwent EVT	Patients experienced seizures after EVT	Incidence (%)	Odds ratio	95% CI (upper)	95% CI (lower)	p-value
384	25	6.51%	1.2046	0.5182	2.7998	0.6654

Table 3: Incidence of ischemic and hemorrhagic stroke among the study population

Total number of stroke patients	Ischemic stroke n(%)	Hemorrhagic stroke n(%)	$\chi 2$	p-value
384	318 (82.81)	66 (17.18)	115.7908	0.00001*

*indicated that the value is significant at p<0.05

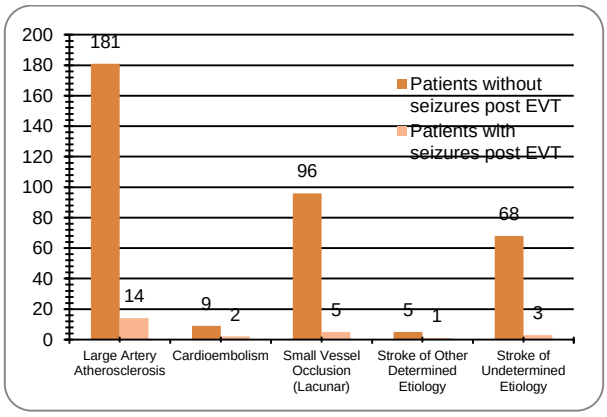

Figure 1: Distribution and Incidence of Post-Endovascular Therapy Seizures in Stroke Patients, Categorized by TOAST Stroke Subtypes

Table 4: Risk factors elevating the incidence of seizures in stroke patients after EVT

S. No	Risk factors	Odds ratio	95% CI (upper)	95% CI (lower)	p-value
1	Stroke severity	0.3976	0.1639	0.9642	0.0413*
2	Hemorrhagic stroke	0.8285	0.1781	3.8553	0.08105
3	Cortical involvement	0.2029	0.0222	1.8543	0.1577
4	Young age	1.2692	0.1454	11.0767	0.8292
5	Early seizures post ETV	2.5838	0.8264	8.0776	0.1026

*indicated that the value is significant at p<0.05

DISCUSSION

This observational investigation determined incidence and risk factors of seizures in stroke patients who underwent EVT. We examined a cohort of 384 patients whereby seizures were observed in 6.51 % of patients after EVT, and a modestly higher odds ratio of 1.2046 for seizure occurrence after EVT was identified, although this difference was not significant. No correlation was found between seizures and age, gender, or prevalent comorbidities such as hypertension, cardiac conditions, and diabetes. Ischemic strokes were substantially more prevalent (82.81%) than hemorrhagic strokes (17.18%), according to the study. Despite the fact that potential risk factors such as hemorrhagic stroke, cortical involvement, younger age, and early seizures following EVT appeared to influence the likelihood of seizures, these associations were not statistically significant. The study highlighted the multifaceted nature of post-EVT seizure prediction and the need for broader, more diverse studies in order to gain a complete understanding. Hence, seizures were a significant complication of EVT for stroke patients. Stroke severity and etiology may influence seizure risk, highlighting the significance of vigilant monitoring and proactive management to reduce incidence of seizures.

According to comparable study that supported our findings, 8.9% (168 out of 1897) of patients experienced seizures after EVT in stroke. Individuals with hemorrhagic stroke were found to be especially susceptible to the advent of seizures. Other risk factors included cortical location of the stroke and the degree of disability caused by the stroke. In addition, it was observed that patients with late seizures had a higher likelihood of developing epilepsy thereafter [19]. Another discovery stated that in 29 (58%) patients, early seizures, occurring within two weeks, were observed. Generalized seizures were more prevalent, affecting 37 (74%) of the patients. More than two seizures occurred in 31 (62%) of patients. Forty patients (80%) had ischemic strokes, with arterial infarcts in 36 (72%) and venous infarcts in 3 (6%). In 10 (20%) patients, intracerebral hemorrhages were detected. The correlation between ischemic heart disease, prior stroke, hypertension, and onset of late seizures (p<0.05). The presence of a previous stroke, ischemic heart disease, hypertension, and hypercholesterolemia was strongly associated to developing late-onset seizures [15]. In a second study conducted in a similar setting, the incidence of post-stroke seizures was reported to be 8% (representing 117 of the 1,548 patients admitted due to stroke) [20]. In a study, significant number of patients (80%) was found to have ischemic infarct, which was consistent with ours. This was in stark contrast to international data indicating an increased incidence of PSS following intracerebral hemorrhage [21].

It was reported through brain imaging that 50% of those who developed seizures had arterial ischemic infarction, 30% had venous infarction, 6.67 percent had ischemic infarction with hemorrhagic transformation, 6.67 percent had intracerebral hemorrhage, and 6.67 percent had subarachnoid hemorrhage. 43.33% of the patients had focal to bilateral tonic-clonic seizures, 33.33% had focal aware seizures, 16.67% had generalized tonic-clonic seizures, and 6.67% had status epilepticus according to the 2017 ILAE criteria. EEG findings revealed focal slowing in 46.67% of patients, focal epileptiform activity in 13.33% of patients, focal activity with secondary generalization in 10% of patients, PLEDS in 6.67% of patients, generalized epileptiform activity in 6.67% of patients, generalized slowing in 6.67% of patients, and normal EEG in 10% of patients. Focal to bilateral tonic-clonic seizures and focal aware seizures were found to be the most prevalent forms of early-onset seizures following stroke, followed by generalized tonic-clonic seizures and status epilepticus [22].

CONCLUSION

In contemporary clinical practice, incidence of seizures following stroke in patients who underwent EVT is significant health concern. Seizures were a significant complication of EVT for stroke patients, influenced by stroke severity and etiology, highlighting the significance of vigilant monitoring and proactive management to reduce the incidence of seizures in this patient population. It was found that there was a significant incidence of post-stroke seizures, highlighting the need for rigorous post-procedure monitoring and intervention strategies. Several significant correlations emerged, including type and location of stroke, its severity, and age of the patient. Importantly, results of this study emphasized need for multifaceted approach to the treatment of stroke patients. While EVT are effective in addressing the immediate threat posed by a stroke, complications such as seizures require equal care. Incorporating a protocol for seizure management into post-EVT care can be crucial for reducing associated morbidity and improving patient outcomes. These findings warrant additional research to develop comprehensive risk assessment tools for predicting the probability of seizures following EVT.

Conflict of Interest: None.

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