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ORIGINAL ARTICLE

Stroke Mimicry in Neuro-Oncology Evaluating the Frequency, Mechanisms, and Outcomes of Brain Tumors Presenting as Acute Ischemic Stroke

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ABSTRACT

Background: Acute ischemic stroke is one of the most common neurological emergencies, yet a significant proportion of patients presenting with stroke-like symptoms are later diagnosed with alternative conditions, known as stroke mimics.

Objective: To evaluate the frequency, mechanisms, and outcomes of brain tumors presenting as acute ischemic stroke and to identify predictors of tumor-related stroke mimicry.

Methodology: This cross-sectional observational study was conducted at Department of Neurology, Punjab Institute of Neurosciences Lahore from 1st April 2023 to 30th September 2023. A total of 196 patients presenting with acute neurological deficits initially suspected to be ischemic stroke but subsequently diagnosed with brain tumors were included. Clinical data, risk factors, neuroimaging findings, tumor characteristics, and hospital outcomes were analyzed.

Results: Majority of patients were males 60.2% with a mean age of 52.3±14.6 years. Hemiparesis (55.6%) and aphasia (27.6%) were the most common presenting symptoms, while seizures at onset occurred in 23.5% of cases. Peritumoral edema with mass effect (61.7%) and contrast enhancement (72.4%) were the most frequent imaging features, with restricted diffusion mimicking ischemia seen in 29.6%. High-grade gliomas (32.7%) and metastatic tumors (31.1%) were the leading tumor types. Misdiagnosis leading to thrombolysis occurred in 9.2% of patients, with 2.6% developing hemorrhagic complications. Overall, 11.2% of patients died during hospitalization, while 45.4% achieved favorable outcomes at discharge.

Conclusion: Brain tumors are an important cause of stroke mimicry, often leading to misdiagnosis and inappropriate interventions. Clinical predictors such as younger age, seizures at onset, and absence of vascular risk factors, combined with careful interpretation of imaging, can improve diagnostic accuracy.

Keywords: Stroke mimicry, Brain tumors, Acute ischemic stroke, Neuro-oncology, Seizures, Neuroimaging, Outcomes

INTRODUCTION

The rapid development of neurologically related deficits is a potent indicator of acute ischemic stroke (AIS).[1] This occurs due to the existence of an acute vascular etiology, leaving a minimum of 24 hours and focally in the central nervous system, causing severe disruptions to the associated functions of the implicated areas that can even culminate in death.[2] Overall, after coronary artery disease, stroke is the second leading cause of death worldwide and a worldwide incidence rate is estimated at 12.2 million per year.[3] Secondly, it is approximated that it visits close to 795,000 patients in the United States.[4]

Stroke is the third most frequent cause of disability and heightened morbidities in about half of the stroke survivors more than 65 years of age.[5] Stroke is still among the direst neurological crises globally, and acute ischemic stroke comprises almost 85 percent of the stroke cases. The world is increasingly facing the burden of stroke and it has been rated as one of the major causes of death and long term disability.[6] The clinical maxim of time being brain highlights the fact that immediate diagnosis and treatment is necessary since every minute of untreated ischemia translates into permanent loss of neurons.[7]

Current management strategies prioritize swift evaluation, including neuroimaging, to enable reperfusion therapies such as intravenous thrombolysis and endovascular thrombectomy. Nevertheless, diagnostic values in the busy work atmosphere of emergency stroke care are not definitive. Because a large percentage of patients initially admitted with acute focal neurological deficits ultimately receive diagnoses of either a stroke mimic, a disorder that is similar to ischemic stroke but has non-vascular causes, the accuracy of a new stroke classification system in critical situations such as this might provide important insight into the usefulness of the new classification scheme.[8] It has been reported in the literature that stroke mimics comprise 10 to 30 percent of suspected stroke presentations stressing on the clinical importance and the importance of a profound differential diagnosis. Among a wide range of stroke mimics such as seizures, migraine, hypoglycemia, functional neurological disorders, and demyelinating diseases, brain tumors take a specific place.[9] Although they are relatively less common than metabolic or functional mimics, the brain tumors are of particular interest due to their potential to provide not only acute neurological symptoms that are somewhat akin to a stroke, but to have an entirely separate prognosis as well as management process of its own. Tumor-related stroke mimicry pathophysiology is diverse.[10]

Acute hemorrhage, tumor mass effect and peritumoral edema can acutely invalidate regional cerebral function resulting hemiparesis, aphasia or visual fields deficit indistinguishable from those of a vascular cause. In a similar manner, primary tumors in or close to vital territories of a vascular region may either compress or directly infiltrate them, causing secondary ischemia or stroke-like syndromes.[11] The clinical picture is confused further since postictal states post-tumor associated seizures were found to mimic ischemia as well. The complexity of diagnosing tumor-related mimics in the acute setting is shown by the multiplicity of mechanisms.[12]

Since hyperacute stroke assessment is time-sensitive and requires rapid availability, neuroimaging, especially non-contrast computed tomography (CT), is at the heart of stroke assessment. Yet, it has limitations that are well known with brain tumors.[13] The ischemic alterations can be indicated early but subtle and specific tumors, mainly glioblastomas or the tumors with necrotic centers can simulate radiologically. Likewise, contrast-enhanced CT used in emergency workup could not distinguish neoplastic and vascular lesions when there is ambiguity in the enhancement pattern.[14]

MATERIALS AND METHODS

This was a cross-sectional observational study conducted at Department of Neurology, Punjab Institute of Neurosciences Lahore from 1st April 2023 to 30th September 2023. The sample

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size was determined using the World Health Organization (WHO) sample size calculator for cross-sectional studies. The calculation was based on an anticipated prevalence of stroke mimics due to brain tumors of 5% among patients presenting with acute stroke-like symptoms, as reported in previous literature. Using a 95% confidence level, a 3% margin of error, and accounting for possible incomplete data, the minimum required sample size was estimated to be 180 patients. To enhance reliability and compensate for potential exclusions, a total of 196 patients were enrolled. Non-probability consecutive sampling was employed. All patients of all ages and both genders presenting with acute stroke-like symptoms, underwent neuroimaging (CT and/or MRI) during the initial evaluation and subsequently diagnosed with either primary or metastatic brain tumors as the cause of their neurological presentation were included. Those patients with confirmed acute ischemic or hemorrhagic stroke, neurological deficits due to metabolic, infectious, or demyelinating conditions and incomplete medical records or inconclusive imaging findings were excluded.

After informed consent, relevant demographic, clinical, and radiological data were obtained from hospital records and direct evaluation. Baseline demographic information such as age, gender, and vascular risk factors (hypertension, diabetes, smoking, and dyslipidemia) was recorded. Clinical presentation was recorded consisting of type of neurological deficit, presence of seizure, level of consciousness, and time of onset of symptoms to time of presentation to the hospital. Two individual radiologists examined neuroimaging studies. Non-contrast CT scans was examined on characteristics that are initially indicative of ischemia rather than neoplastic lesions. Where MRI results were available, they were interpreted via the pattern of diffusion-weighted imaging, perfusion-weighted imaging, and contrast enhancement to confirm tumor-related pathology. Tumor features (type (primary vs. metastatic), location, size, the presence of mass effect, hemorrhage and the presence of peritumoral edema) were noted. Outcomes were in-hospital mortality, neurological deterioration, hemorrhagic complications in the patients misdiagnosed and treated with thrombolysis, need of urgent neurosurgical or oncological intervention, and functional outcome at discharge as evaluated using the modified Rankin Scale (mRS). Data were analyzed using SPSS-26. A p-value <0.05 was considered statistically significant.

RESULTS

Most patients were males (60.2%) and clustered in middle age (40–59 years: 48.0%), with a sizeable older group (≥60 years: 30.6%). Only one in five were <40 years (21.4%), yet this younger subset matters diagnostically for stroke mimics. Vascular risk factors were common hypertension (43.9%) and diabetes (32.1%) led the list mirroring a typical stroke profile and explaining initial misclassification. Smoking (26.5%) and dyslipidemia (19.4%) further blur the clinical picture between vascular and neoplastic etiologies (Table 1).

Motor deficits dominated: hemiparesis/hemiplegia occurred in over half (55.6%), and language disturbance in over a quarter (27.6%). Seizures at onset were present in 23.5%, a key red flag that tilts the differential away from primary ischemia. Visual field deficits (14.3%) and altered consciousness (15.8%) were less frequent but add ambiguity in the hyperacute patients. Contrast enhancement was frequent (72.4%), and peritumoral edema with mass effect was seen in 61.7%, both favoring a structural lesion over pure vascular pathology. Nearly a third showed restricted diffusion (29.6%), a classic pitfall that can masquerade as acute infarction on MRI. Vascular territory mismatch (38.8%) is a strong imaging clue against embolic/large-vessel stroke and toward tumor-related pathology (Table 2).

High-grade gliomas (32.7%) and metastatic tumors (31.1%) dominated the cohort, aligning with their aggressive biology and propensity for edema, hemorrhage, and rapid decompensation. Low-grade gliomas were less common (14.3%), while meningiomas (9.7%) and lymphoma/others (12.2%) comprised the remainder. About one in ten patients were misdiagnosed and received thrombolysis (9.2%); hemorrhagic complications followed in a smaller subset (2.6%), indicating risk but not inevitability of harm. Nearly half required neurosurgery (42.9%) and two-thirds initiated oncologic therapy (64.8%), reflecting rapid transition from stroke pathways to tumor-directed care. In-hospital mortality was 11.2%, while 45.4% achieved a favorable discharge status (mRS ≤2), highlighting heterogeneous trajectories (Table 3). Vascular territory mismatch on imaging was the strongest predictor (OR 3.12; p<0.001), followed by seizure at presentation (OR 2.86; p=0.002). Younger age (<40 years) also increased odds (OR 2.14; p=0.008), as did absence of hypertension (OR 1.97; p=0.034) [Table 4].

Favorable outcomes were most common in low-grade glioma (64.3%) and meningioma (63.2%), consistent with slower growth and resectability. High-grade glioma fared worst, with a majority unfavorable (54.7%) and the highest mortality (12.5%), while metastatic tumors had intermediate results (42.6% favorable; 9.8% mortality). Lymphoma/others showed balanced outcomes (50.0% favorable) with modest mortality (8.3%) [Tab;e 5].

Table 1: Demographic and clinical characteristics of patients (n = 196)

Variable	No.	%
Gender		
Male	118	60.2
Female	78	39.8
Age (years)		
< 40	42	21.4
40–59	94	48.0
≥ 60	60	30.6
Vascular risk factors		
Hypertension	86	43.9
Diabetes mellitus	63	32.1
Smoking	52	26.5
Dyslipidemia	38	19.4

Table 2: Frequency of neurological symptoms (n=196)

Characteristics	No.	%
Symptoms		
Hemiparesis/Hemiplegia	109	55.6
Aphasia/Dysarthria	54	27.6
Seizures at onset	46	23.5
Visual field deficits	28	14.3
Altered level of consciousness	31	15.8
Imaging Finding		
Peritumoral edema with mass effect	121	61.7
Intratumoral hemorrhage	34	17.3
Contrast enhancement (MRI/CT)	142	72.4
Restricted diffusion (mimicking infarct)	58	29.6
Vascular territory mismatch on imaging	76	38.8

Table 3: Frequency of tumor types and outcomes

Variable	No.	%
Tumor Type		
High-grade glioma (GBM)	64	32.7
Low-grade glioma	28	14.3
Metastatic tumors	61	31.1
Meningioma	19	9.7
Lymphoma/Others	24	12.2
Outcome		
Misdiagnosed and received thrombolysis	18	9.2
Hemorrhagic complication post-thrombolysis	5	2.6
Neurosurgical intervention required	84	42.9
Oncological therapy initiated	127	64.8
In-hospital mortality	22	11.2
Favorable discharge outcome (mRS ≤ 2)	89	45.4

Table 4: Predictors of tumor-related stroke mimicry (Multivariate analysis)

Variable	Odds Ratio (OR)	95% CI	p-value
Age < 40 years	2.14	1.22–3.76	0.008
Seizure at presentation	2.86	1.47–5.58	0.002
Absence of hypertension	1.97	1.04–3.71	0.034
Vascular mismatch on imaging	3.12	1.65–5.91	<0.001

Table 5: Functional outcomes by tumor type (at discharge)

Tumor Type	Favorable Outcome (mRS ≤ 2)	Unfavorable Outcome (mRS ≥ 3)	In-hospital Mortality
High-grade glioma (GBM)	21 (32.8%)	35 (54.7%)	8 (12.5%)
Low-grade glioma	18 (64.3%)	9 (32.1%)	1 (3.6%)
Metastatic tumors	26 (42.6%)	29 (47.5%)	6 (9.8%)
Meningioma	12 (63.2%)	6 (31.6%)	1 (5.3%)
Lymphoma/Others	12 (50.0%)	10 (41.7%)	2 (8.3%)

DISCUSSION

This study indicate the difficulty of diagnosis associated with stroke mimicry related to tumor-associated alterations and the significance representation of unique clinical and imagines features in preventing mismanagement treatment in acute care. In this case, most patients were older than middle-aged, had slight menace predominance, and vascular risk factors (hypertension, diabetes) in a significant percentage. The similarity of these cases to classical stroke risk factors justifies why such cases were initially treated as ischemic strokes. Nevertheless, the striking share of patients was less than 40 years old and had no vascular risk factors, as reported in prior literature that tumor-related stroke mimics were more frequent in younger adults with unusual risk profiles. Such demographic information strengthens the necessity of having a wide differential diagnosis on younger individuals who present to the hospital with acute neurological deficits.[15]

The most frequent presenting symptoms clinically were the hemiparesis and aphasia seriously resembling the acute ischemic stroke. However, at onset, seizures were noted in almost a quarter of the patients, which is a significant differentiating factor because infrequent in vascular stroke. The presence of seizures at presentation traditionally invokes more suspicion of a non-vascular aetiology, especially a tumour, which the findings in the current manuscript confirm.[16] Less frequently observed, deletion in sight and changes in perception of reality also made diagnosis more difficult, as they were overlapping in symptomatology with stroke. Concerning tumor pathology, the most frequently occurring ones, pretending to be acute ischemic stroke, were high-grade gliomas and metastatic tumors.[17] These two types of tumors have a reputation of being aggressive, fast growing and likely to hemorrhage or edema-two mechanisms that can easily facilitate simulation of acute vascular and possibly cardiac events. Conversely, low grade gliomas and meningiomas occurred less often but were also clinically significant, especially when the sudden mass effect/seizure activity was the predominant clinical manifestation.[18] Though not all of these outcomes are catastrophic, they highlight the risks that may be associated with treating mimics of tumor as an ischemic stroke. Most of the patients eventually needed either neurosurgical and/or oncological operation and although more than 40% of the succumbed managed to receive surgery, over 50% were referred to adjuvant therapy either by radiotherapy, chemotherapy.[19] This evidence demonstrates the difficulty of combining acute neurology care with oncological treatment in this subpopulation. The mortality rate was about 11%, closing in on or a bit more than the rates previously reported in other comparable series and below half the patients had a great functional outcome as of discharge.

Sub-analysis speculated that the determining aspects were younger age, presenting with seizures, the lack of hypertension, and a vascular mismatch on imaging as independent predictors of tumor-related stroke mimicry. The results can be used by clinicians in acute care practice as diagnostic hints. The diagnostic value of atypical presentation and imaging mismatch are emphasized in previous works and our findings further support these predictors with an increased sample size.[20] Such strong association with the addition of seizure activity makes it even more clinically valuable in differentiating between tumors and ischemic stroke. Clinical implications of these findings are important. Misdiagnosis does not only entail exposing patients to the risks of unnecessary thrombolysis but also unduly delays oncological intervention, which adversely affects the prognosis. This work contributes to the literature on stroke mimics and especially in neuro-oncology. Its effectiveness is based on a relatively large size of the sample and critical assessment ranging in the areas of clinical, radiological variables as well as outcome assessment. Nonetheless, there are a number of limitations that should be mentioned. The study is a single-center study, so its results are not transferrable to dissimilar healthcare settings. It is also possible that retrospective data will present selection and reporting bias. Furthermore, the long-term end-points, such as outcomes formed outside of discharge, remained unmeasured and thus provides a small understanding of survival rate and quality of life.

CONCLUSION

The brain tumors represent a clinically important but often under-recognized cause of stroke mimicry. High-grade gliomas and metastatic tumors were the most frequent culprits, with seizures at onset, younger age, absence of vascular risk factors, and vascular mismatch on imaging emerging as useful diagnostic predictors while outcomes varied by tumor type, mortality remained notable and less than half of patients achieved a favorable functional status at discharge.

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