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RESEARCH

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# Spontaneous posterior fossa hemorrhage: profile and functional outcome in patients attending Tanta stroke unit

Mahmoud Hamed Nassar[1], Basem Hamdy Fouda[1], Ahmed Safwat Abd ElMohsen Elsaid[1], Wafik Said Bahnasy[1*], Ehab Ahmed Shawky El-Seidy[1] and Ahmed Mustafa Kishk[1]

## Abstract

**Background** The most dangerous and least curable type of stroke is spontaneous intracerebral hemorrhage (ICH), and prognosis is highly correlated with location and size in the posterior fossa. The objective of this work was to estimate the frequency of posterior fossa hemorrhage (PFH) in Tanta University Hospitals, as well as identify functional outcomes and mortality in PFH.

**Methods** This study was performed on 33 posterior fossa hemorrhagic patients and 119 posterior ischemic stroke patients (PCIS) submitted to the CT brain and the MRI brain, using the following scales: GCS and NIHSS, and the intracerebral hemorrhage scale (ICH score).

**Results** Posterior fossa hemorrhage (PFH) represents 16.83% of total hemorrhagic stroke in the ER. Vertigo and DCL are more common in PFH (60.6%, 48.4%) than in PCIS. 82% of PFH patients had hypertension (HTN) hemorrhage. The cerebellum is the most common site for PFH (48%), pontine (24%), thalamic (18%), and midbrain (9%). PFH had unfavorable outcomes in 55% of the studied patients; the MRS mean was 4; and 39% died in the follow-up.

**Conclusion** Posterior fossa hemorrhage is a potentially serious neurovascular emergency associated with complex symptomatology. PFH demonstrates diverse prognoses depending on the location of the intracerebral hemorrhage and the size of the hematoma.

**Keywords** Posterior fossa hemorrhage, Modified Rankin scale, Posterior circulation stroke, Tanta University Hospital

## Introduction

Due to an increase in life expectancy, stroke has had a significant negative influence on society and healthcare globally and is a leading cause of death and disability. Significant improvements in stroke treatment and prevention have been realized over the past few decades [1]. The diagnosis of a posterior circulation stroke is often challenging thanks to the vast area of brain tissue affected. Commonly used scales for assessment of signs and symptoms of posterior circulation stroke (PCS) in addition to false-negative neuroimaging stand as an obstacle for pre- and early intrahospital awareness [2].

9 to 15% of all intracerebral hemorrhages (ICH) are caused by posterior fossa hemorrhage (PFH). It can lead to potentially fatal complications, including compression of the pons and medulla, which can impair awareness, cause respiratory failure, and cause malfunction in the lower cranial nerves. Acute hydrocephalus may occur secondary to the obstruction of the fourth ventricle with herniation of the posterior cerebral fossa. The reported mortality rate from PFH varies greatly and may be as high as 85% [3]. The causes of hemorrhage in the anterior

*Correspondence:
Wafik Said Bahnasy
wafiq.elbahnasi@med.tanta.edu.eg
[1] The Departments of Neurology, Faculty of Medicine, Tanta University, Tanta 31527, Egypt

circulation and posterior fossa hemorrhage are identical [4].

An etiological classification system for ICH called SMASH-U is a reliable predictor of post-ICH hematoma growth and mortality. The categories were as follows: hypertension, systemic illness, amyloid angiopathy, structural lesion, medicine, or uncertain [5].

### Aim of the work

This work aimed to estimate clinical, laboratory, and radiological aspects of posterior fossa hemorrhage and functional outcomes in patients who were admitted to the Stroke Unit of the Neuropsychiatry Department, Tanta University Hospitals.

## Methods

This work was a prospective cohort longitudinal study conducted on 33 posterior fossa hemorrhage patients and 119 posterior ischemic stroke patients (PCIS). They attended the neurology emergency room (ER) at the Department of Neuropsychiatry and Center of Neurology and Psychiatry, Tanta University Hospital, between April 2022 and October 2022. Included patients were followed up on monthly visits for 3 months post-discharge. Tanta Stroke Chain (TSC) adopts the 2015 Guidelines for the management of spontaneous intracerebral hemorrhage [6].

### Inclusion criteria

Patients who attended the neurology (ER) during the period of the study with acute posterior circulation stroke whether ischemia or hemorrhage confirmed by vascular imaging.

### Exclusion criteria

Patients with posterior circulation subarachnoid hemorrhage. Patients who had contraindications to MRI (pacemaker, metallic cardiac valve, irritable patients, etc.) or contraindications to CTA (renal impairment, hypersensitivity). Patients with anterior circulation stroke.

Brain computerized tomography (CT): used General Electric Optima 128 multi-slice scanner and Toshiba Aquilion multi-slice 16 at the radiology department of Tanta University Hospital and Tanta Neuropsychiatry Center.

Brain MRI was performed using GE Healthcare, Milwaukee, WI, USA. The images were attained by a 1.5- to 1.5-Tesla closed magnet at the radiology department of Tanta University Hospital (GE Medical Systems, Milwaukee, USA) with a quadrature 8-channel head coil.

The patients were admitted using the following scales at admission and follow-up: including Glasgow Coma Score (GCS) National Institute of Health Stroke Scale (NIHSS), and intracerebral hemorrhage severity for patients with posterior circulation hemorrhage (ICH score) [7].

The patients were followed after discharge every month at regular visits for three months through a modified Rankin scale (mRS) The modified Rankin scale (mRS), a 7-level, clinician-reported measure of global disability, is the most widely employed outcome scale in acute stroke trials [8].

Statistical analysis was conducted using SPSS Prism, version 20, 2013 created by IBM, Illinois, Chicago, USA. Statistical data were tested using the mean, standard deviation, Student's *t*-test, Chi-square, and linear correlation coefficient. *P*-value < 0.05 was considered statistically significant.

## Results

The results showed 119 patients (78%) were PCIS, while posterior fossa hemorrhage patients were 33 (22%).

33 patients had posterior fossa hemorrhage aged 45–88 (68.2 ± 9.7); 21 (64%) were male. 3 (9%) patients had DM, 29 (88%) patients had HTN, 4 (12%) patients had IHD, 2 patients were AF (6%), 12 (36%) patients were smokers, 4 (12%) patients had a history of hypercholesterolemia, 2 (6%) patients were hepatic (2 had a history of HCV treatment), and 1 (3%) patient had renal disease (HTN nephropathy).

ER assessment: SBP 150–220 (181.9 ± 18.4), DBP 80–120 (96.6 ± 10.1), RBS 102–370 (209.8 ± 78.8). GCS 3–15 (10.4 ± 5.1), NIHSS 2–27 (13.5 ± 10.1), ICH SCORE 1–5 (2.7 ± 1.6), plt 140–350 (231.9 ± 60.3), INR 1–5 (1.3 ± 0.4).

Clinical presentation of posterior fossa hemorrhage for patients in our study showed that 20 (60.60%) patients had vertigo, followed by 16 (48.48%) patients had DCL (disturbed conscious level), and 14 (42.42%) patients had weakness. The next frequent manifestations included ataxia in 12 patients (36.36%), 8 patients had a headache (24%), 8 patients complained of dysarthria (24%), and 5 patients had diplopia (15%).

Ocular manifestations in these patients occurred in 5 patients, including 2 with horizontal gaze palsy, 2 with vertical gaze palsy, and 1 with nystagmus.

The results showed a difference in the initial clinical picture of PCIS and posterior fossa hemorrhage patients, indicating DCL (disturbed conscious level) and vertigo have a significant increase in posterior fossa hemorrhage patients compared to PCIS patients (*P*-value < 0.005) (Table 1).

Distribution of posterior fossa hemorrhage was considered etiologically according to the SMASH-U classification: 27 (82%) patients had HTN hemorrhage, 2 (6%) patients had amyloid angiopathy, 2 (6%) patients were due to medication (warfarin toxicity), 1 (3%) patient had

**Table 1** Comparison of PCIS and posterior fossa hemorrhage in the initial clinical picture in ER

| Symptom | Type of stroke | | | | Chi-square | |
|---|---|---|---|---|---|---|
| | Ischemia | | Hemorrhage | | | |
| | *N* | % | *N* | % | $X^2$ | *P*-value |
| Weakness | 72 | 60.50 | 14 | 42.42 | 3.068 | 0.080 |
| DCL | 27 | 22.68 | 16 | 48.48 | 9.053 | 0.003* |
| Dysarthria | 20 | 16.80 | 8 | 24.24 | 1.075 | 0.300 |
| Vertigo | 46 | 38.65 | 20 | 60.60 | 5.650 | 0.017* |
| Crossed | 12 | 10.08 | 0 | 0.0 | 3.537 | 0.060 |
| Visual field | 12 | 10.08 | 0 | 0.0 | 3.537 | 0.060 |
| Diplopia | 24 | 20.16 | 5 | 36.36 | 0.359 | 0.549 |
| Sensory | 12 | 10.08 | 0 | 0.0 | 3.537 | 0.060 |
| Headache | 26 | 21.84 | 8 | 48.48 | 0.126 | 0.017* |
| Ataxia | 35 | 29.41 | 12 | 24.24 | 0.719 | 0.396 |

* Significant DCL: disturbed conscious level

systemic diseases (renal failure), and 1 (3%) patient had a structural vascular anomaly (arteriovenous fistula) (Fig. 1).

For the distribution of posterior fossa hemorrhage according to the site of hemorrhage. Our study figured out that 16 (48%) patients had cerebellar hemorrhage, 8 (24%) patients had pontine hemorrhage, 6 (18%) patients had thalamic hemorrhage, and 3 (9%) patients had midbrain hemorrhage.

Patients were followed up using mRS with the number of patients who had favorable mRS (0–2) was 15 patients (45%), against 18 patients (55%). mRS after 1 month 1–6 ($4.2 \pm 1.9$), mRS after 2 months 1–6 ($2.6 \pm 1.8$), mRS after 3 months 1–4 ($2 \pm 1.5$). During

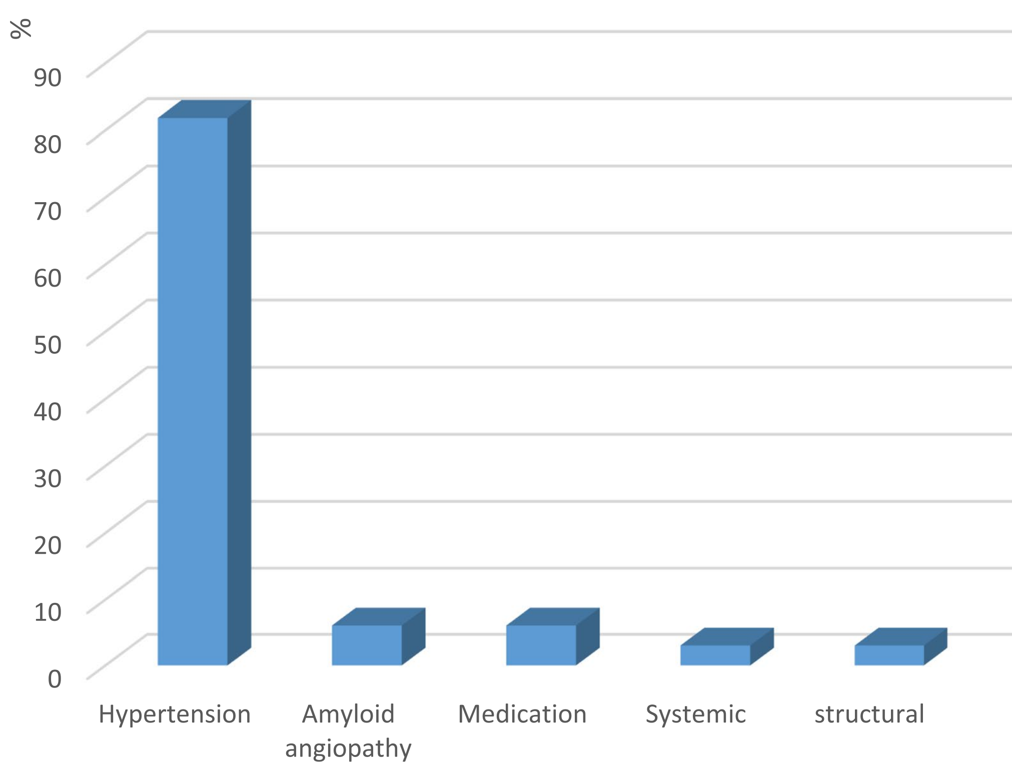


**Fig. 1** Distribution of posterior fossa hemorrhage etiologically according to SMASH-U classification

the study, 13 patients died, 10 in the first month (30%), and 3 in the second month (9%) after follow-up.

The results showed a significant positive correlation between the ICH score scale, the NIHSS of posterior fossa hemorrhage patients, and the modified Rankin scale. There is a negative and significant correlation between the age and SBP of PFH patients and the modified Rankin scale (Fig. 2).

## Discussion

According to the study, PFH is more prevalent in older adults (66% of whom are men). Increased degenerative alterations brought on by aging put brain vessels at risk for rupture.

The most prevalent risk factor among the individuals in the study was hypertension. More than 88% of our patients have it. Lipohyalinosis, which comprises the deterioration, fragmentation, and necrosis of small penetrating arteries, is caused by chronic hypertension. Chronic hypertension can result in artery microaneurysms, also known as Charcot–Bouchard aneurysms.

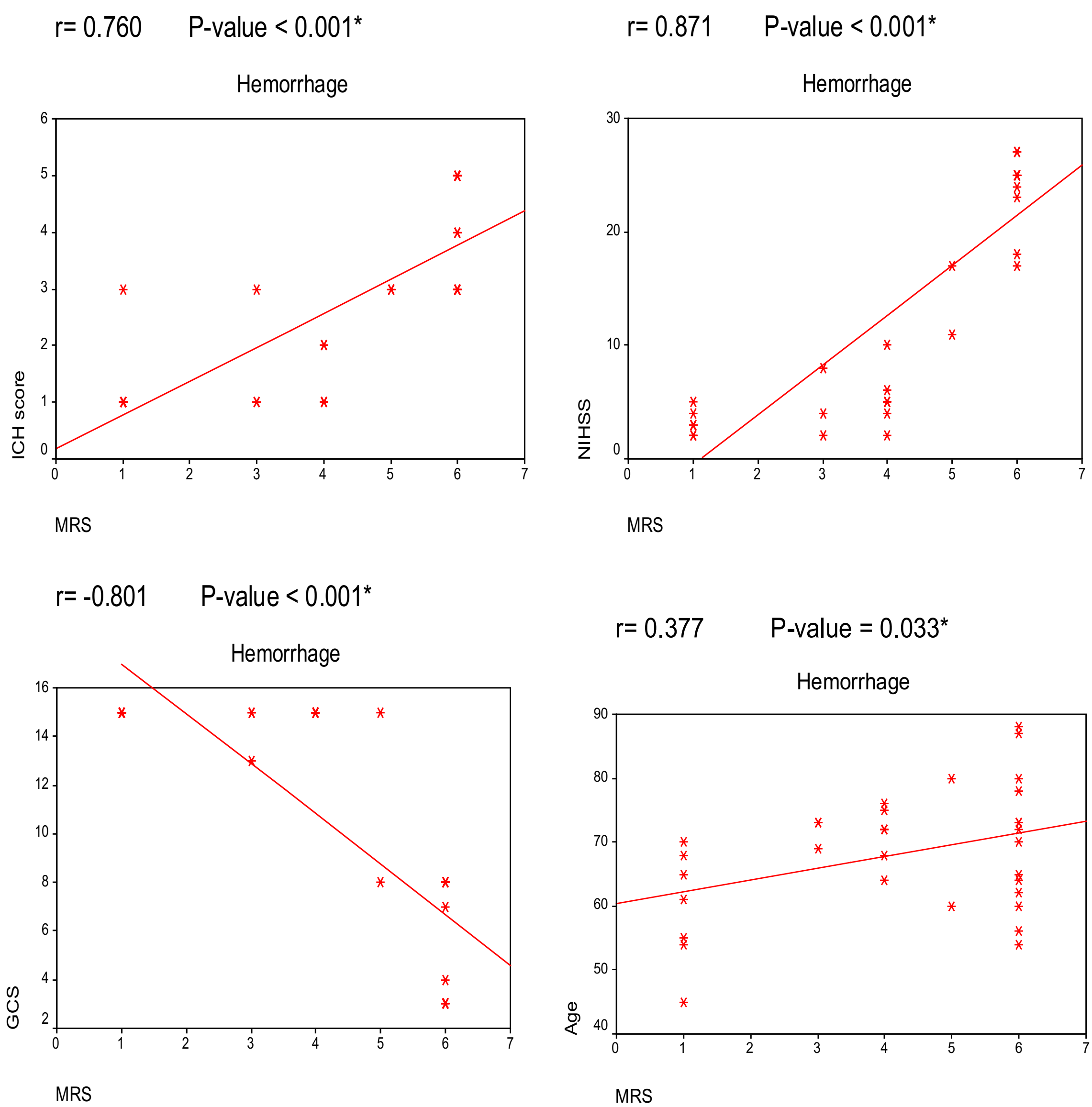


**Fig. 2** Positive significant correlation between the ICH score scale, NIHSS of posterior fossa hemorrhage patients, and modified Rankin scale. Negative significant correlation between the age of PFH patients and the modified Rankin scale

Blood may extravasate into the brain parenchyma if these microaneurysms or the brittle vessel walls of small and medium-sized arteries rupture during pressure spikes [9].

According to Magid-Bernstein and colleagues [10], dysregulation of matrix metalloproteinases (MMPs), elastin, and collagen may be the cause of enhanced arterial stiffening that results in hypertensive vasculopathy and ICH. Other pathogenic processes, such as metabolomic syndrome, neurohormonal and inflammatory disorders, and dysregulation of the renin–angiotensin system, have also been put up to explain these age-related structural and mechanical alterations. The malfunction of the endothelium and extracellular matrix may be explained by an increase in the proinflammatory cytokines TNF (tumor necrosis factor) and IL-6, as well as leukocyte infiltration into the perivascular spaces.

According to the study, NIHSS is higher in PFH patients with a mean of 13 than in PCIS patients with a mean of 8. Also, GCS in PFH, with a mean of 10.5, is less than in PCIS, with a mean of 13. The severity measured by the ICH score had a mean of 2.5 at admission. High NIHSS and low GCS might be due to a low number of studied patients, their old age, and severe uncontrolled HTN at admission (Fig. 3).

These findings contradict Wessels and colleagues' 2004 findings [11]. Their findings revealed that the average lower GCS score at admission was 7. The mean NIHSS score was 29. This is because there were only 29 patients in the study's sample, which was smaller. They were all pontine hematomas, which can also have prenatal consequences. The majority of the patients exhibited intraventricular extension and dorsal pontine hemorrhage.

In their investigation, Chen and colleagues [12] demonstrated that GCS 13–15 [14] and NIHSS were present in the brain stem group [4–10] and cerebellar group [2–8]. This is because there were 195 patients in the trial, of whom 75% had HTN, and because the blood pressure was quickly brought down to the desired level within 24 h.

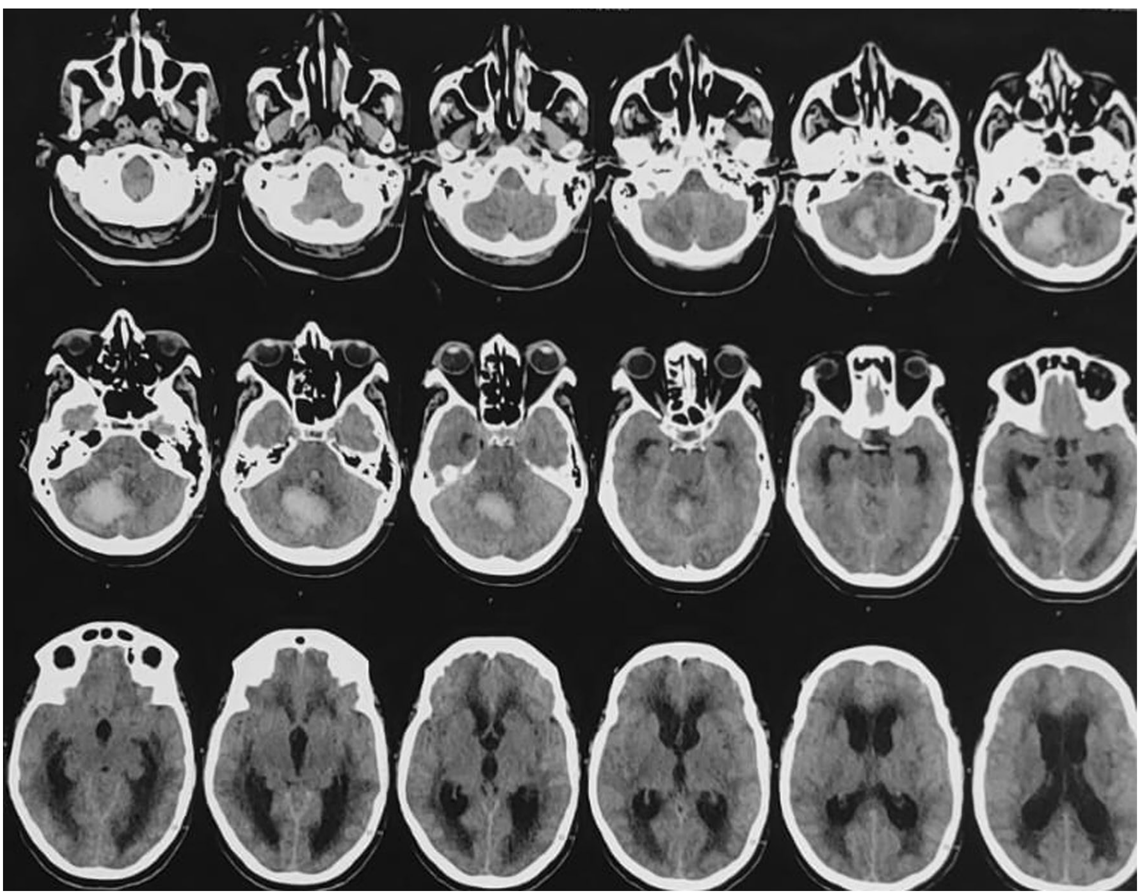

**Fig. 3** A case vignette. Female patient, 55 years old, hypertensive. She presented with acute onset unsteadiness with vomiting and left-side weakness. GCS: 13. NIHSS: 6. ASPCS: 3. Onset to door: 4 h after stroke. By examination, she was drowsy with left-side weakness grade 4, ataxia to the left, and multidirectional nystagmus. She was discharged after 3 weeks. She did not do a shunt operation or surgical decompression after a neurosurgical consultation. mRS:3 after 3 months

The research coincided with Ilyas and Chavan's findings from 2021 [13]. The ICH score could be used to predict outcomes during the hospital stay, at discharge, and follow-up in the 1st and 2nd months.

Vertigo was found to be the most prevalent symptom in 20 (60.60%) of the patients, followed by DCL in 16 (48.48%), weakness in 14 (42.42%), ataxia in 12 (36.36%), headaches in 8 (24%), dysarthria in 8 (24%), and diplopia in 5 (15%) patients. In our research, we found that 16 patients' cerebellar affection was the cause of this. Weakness was related to the brain stem together with cerebellar peduncle dysfunctions. DCL due to the effect on the reticular activating system in the upper third of the pontine tegmentum, mass effect, hydrocephalus, intraventricular extension, and affection of the cranial nuclei leading to dysarthria, dysphagia, aspiration pneumonia, and abnormal breathing patterns requiring mechanical ventilation. Intraventricular hemorrhage can cause obstructive hydrocephalus, necessitating the placement of an external ventricular drain (EVD) to allow the removal of cerebrospinal fluid (CSF) to prevent the development of and treat elevated intracranial pressure (ICP).

Distribution of PFH patients etiologically according to SMASH-U classification: 27 (82%) patients had HTN hemorrhage, then amyloid angiopathy in 2 (6%) patients, medication (warfarin toxicity) in 2 (6%) patients, 1 (3%) patient had systemic diseases (renal failure), and 1 (3%) patient had structural vascular anomalies (arteriovenous malformation).

This result was in the same line as the work of Jia and colleagues [5] infratentorial group of 198 patients: 10 (5.5%) patients were due to structural lesions, 1 (0.5%) patients were due to medication, 3 (1.5%) patients were due to amyloid, 11 (5.5%) were due to systemic diseases, 153 (77%) patients were due to HTN, and 20 (10%) patients were undetermined.

The study showed that patients who had favorable mRS (0–2) were (45%), while those with unfavorable mRS were (55%). 13 (39%) patients died (30%) in the first month and (9%) in the second month after follow-up.

This result was consistent with previous reports from Chen and colleagues [12], who found major disabilities were found in 40.0%) of the brain stem group and in 33% of the cerebellar group, while death was in 13% of the brain stem group and 33% of the cerebellar group. Due to the effect on the reticular activating system in the upper third of the pontine tegmentum, mass effect, hydrocephalus, intraventricular extension, and affection of the cranial nuclei leading to dysarthria, dysphagia, aspiration pneumonia, and abnormal breathing patterns requiring mechanical ventilation, Patients who survive the initial bleeding event remain at risk for herniation and mass effects from PFH and developing perihematomal edema (PHE).

In our study, there were no one of the PFH patients (cerebellar) underwent surgical decompression or ventriculostomy. Neurosurgeons still prefer medical treatment over surgical interference thanks to low GCS, rapid deterioration, old age of our group, and the low number of cases in our study.

There is still debate about the medical versus surgical management of cerebellar hemorrhage, despite the guidelines for the management of spontaneous intracerebral hemorrhage produced by the American Heart Association Stroke Council, which recommends surgical removal of hematoma for patients with PCFH and neurologic deterioration, brainstem compression, or hydrocephalus [6].

To allow rational treatment decisions several studies were conducted to identify clinical or radiological factors predicting prognosis. The following factors were suggested: GCS score at admission, the evolution of clinical signs, hematoma size on CT, hematoma location on CT, presence of hydrocephalus on initial CT, compression of the 4th ventricle or brainstem compression on CT, presence of intraventricular blood on CT, underlying secondary cause of hemorrhage versus idiopathic/hypertensive hemorrhage Witsch and colleagues [14].

At least two therapeutic approaches are currently quite popular. One was submitted in 1994 by Kobayashi and coworkers [15]. This technique employs the hematoma size on the CT scan and the patient's GCS score at admission as distinguishing variables. This suggests that patients with a minor hematoma and a high GCS score upon entry. All patients with grade III cisterns had the hematoma removed, as well as those with grade II cisterns, when the GCS score declined in the absence of treatable hydrocephalus. In patients with grade III cisternal compression, the prognosis was typically unfavorable, with 0% (grade III cisterns with a GCS score of 8) and 38% (grade III cisterns with a GCS score > 8) attaining a positive outcome. Patients with grade II cisternal compression and a GCS score of less than 8 responded similarly to medical care alone, CSF draining alone, or hematoma evacuation.

The second approach is similarly based on a therapy procedure that has been prospectively studied, according to a study by Kirollos and colleagues [16]. The diameter of the fourth ventricle is assessed on a CT scan and categorized as either normal (grade I), compressed (grade II), or absent (grade III), regardless of the amount of the hematoma. The GCS score [13], the second factor, is taken into account. All patients with grade III cisterns had the hematoma removed, as well as those with grade

II cisterns, when the GCS score declined in the absence of treatable hydrocephalus.

## Conclusions

Posterior fossa hemorrhage is a neurovascular emergency associated with multiple manifestations, ranging from isolated cranial nerve palsy to coma. PFH demonstrates diverse prognoses depending on the location of the intracerebral hemorrhage and the size of the hematoma. PFH had a worse prognosis and higher mortality than PCIS.

## Recommendations

Improving symptom recognition prehospitally and during triage. Increasing knowledge and awareness among EMS staff regarding atypical stroke syndromes. We recommend close follow-up for END and early neurosurgical consultation for early intervention, which may improve the outcome of these patients. Lifestyle modification and vascular risk reduction with health systems-based interventions for secondary stroke prevention. Further prospective randomized studies with larger sample sizes and comparisons with control groups are warranted to emphasize and confirm our results.

## Limitations

Since this was a single-center study, we cannot account for referral pattern changes in other stroke centers in the country. A low number of patients may not have a population representative of other settings for acute stroke care. However, it highlights the need to have certain parameters added to the currently used stroke scale or the employment of a different scale for posterior circulation stroke. Long-term follow-ups are required to provide further insight into the clinical features and prognosis of PCS, as we followed up with patients for only 3 months. No patients in our study had posterior fossa surgery for decompression or ventricular drainage; thus, we did not have data or results about the outcome of these intervention procedures.

**Abbreviations**

| | |
|---|---|
| ACIS | Anterior circulation ischemic stroke |
| AHA/ASA | American Heart Association/American Stroke Association |
| BA | Basilar artery |
| CT | Computerized tomography |
| CTA | Computerized tomography angiography |
| DCL | Disturbed conscious level |
| DM | Diabetes mellitius |
| DWI-PC-ASPECTS | Diffusion-weighted imaging posterior circulation-Alberta Stroke Program Early CT Score |
| EMS | Emergency Medical Services |
| EVD | External ventricular drain |
| GCS | Glasgow Coma Score |
| HINTS | Head-Impulse Nystagmus Test-of-Skew |
| HTN | Hypertension |
| ICH | Intra-cerebral hemorrhages |
| ICP | Intra-cerebral pressure |
| IHD | Ischemic heart diseases |
| IVT | Intra-venous thrombolysis |
| MRI | Magnetic resonance imaging |
| mRS | Modified Rankin scale |
| NIHSS | National Institute of Health Stroke Scale |
| PCIS | Posterior circulation ischemic stroke |
| PCS | Posterior circulation stroke |
| PFH | Posterior fossa hemorrhage |
| PHE | Perihematomal edema |
| TSC | Tanta Stroke Chain |
| SMASH-U | Structural lesion, medication, amyloid angiopathy, systemic disease, hypertension, or undetermined |
| TIA | Transient ischemic attack |

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**Author contributions**
MHN: participated in the study's idea, design, patients' selection, neurological examination, statistical analysis, data analysis, references collection, manuscript writing, revision, and final approval. BHF: participated in the study's idea, design, patients' selection, neurological examination, statistical analysis, data analysis, references collection, manuscript writing, revision, and final approval. ASE: participated in the study's design, patients' selection, statistical analysis, data analysis, references collection, manuscript writing. WSB: participated in study design, patients' assessment, manuscript revision, and final approval. EAE: participated in study's idea and design, patients' assessment and inclusion, data analysis, statistical analysis, manuscript writing, revision and final approval. AMK: participated in the study's idea, design, patients' selection, neurological examination, statistical analysis, data analysis, references collection, manuscript writing, revision, and final approval. All authors state that they have read and approved the manuscript.

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**Availability of data and materials**
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Declarations

**Ethics approval and consent to participate**
The manuscript was approved from The Research Ethics Committee and Quality Assurance Unit, Faculty of Medicine, Tanta University. The http://tqac.tanta.edu.eg/new-tqac/. QualityAssuranceUnit@hotmail.com. Approval Code: 35348/3/22. Name of the PI: Ahmed Safwat Abd El Mohsen El said. Name of the department: Neuropsychiatry. Type of the research: Promotion research. Date of approval: March 2022. The study's protocol was approved by The Research Ethics Committee and Quality Assurance Unit, Faculty of Medicine, Tanta University. Participation was voluntary, informed consents were approved by all participants and any possible risks were clarified.

**Consent of publication**
Not applicable.

**Competing interests**
All authors disclose that they have no competing interests related to the study.

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## Publisher's Note