ORIGINAL ARTICLE

Distinct Risk Profiles in Posterior vs Anterior Circulation Strokes: A Prospective Study from Western India

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Abstract

Background: Anterior (ACS) and posterior circulation strokes (PCS) differ in clinical presentation, vascular pathology, and associated risk factors.

Objectives: The aim of the study was to compare vascular risk profiles, clinical characteristics, neuroimaging findings, and outcomes between ACS and PCS patients in a hospital-based cohort.

Methods: A prospective observational study was conducted at a tertiary care hospital, from January to December 2021. Consecutive patients with confirmed anterior or posterior circulation stroke were included. Demographics, National Institutes of Health Stroke Scale (NIHSS) scores, vascular risk factors (hypertension, diabetes, dyslipidemia, smoking, metabolic syndrome), presenting symptoms, computed tomography (CT) imaging findings, and outcomes [modified Rankin Scale (mRS) at discharge, mortality] were recorded. Univariate and multivariate logistic regression analyses were performed.

Results: Among 376 stroke patients analyzed, 274 (72.9%) had ACS and 102 (27.1%) had PCS. PCS patients were significantly younger (54.6 vs 61.2 years; $p = 0.003$), with a higher prevalence of hypertension (78.4 vs 62.8%; $p = 0.008$), current smoking (45.1 vs 28.8%; $p = 0.002$), metabolic syndrome (41.2 vs 28.5%; $p = 0.02$), and poor glycemic control (HbA1c >8% in 51.2 vs 38.6%; $p = 0.04$). PCS presented more often with vertigo (78.4%), ataxia (62.7%), and visual symptoms (54.9%), while ACS typically presented with hemiparesis and aphasia. Despite lower NIHSS scores, brainstem infarcts in PCS accounted for most in-hospital deaths. Multivariate analysis identified hypertension, smoking, age <55, and metabolic syndrome as independent predictors of PCS.

Conclusion: PCS affect a younger demographic and are independently associated with modifiable metabolic and vascular risk factors. Their atypical presentation and distinct risk profile call for targeted screening and prevention strategies, particularly in younger Indian adults.

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Introduction

Stroke remains one of the leading causes of mortality and long-term disability in India, with ischemic strokes accounting for nearly 65.3% of all cases.[1] Among these, anterior circulation strokes (ACS) are more commonly encountered in clinical practice, while posterior circulation strokes (PCS) comprise approximately 17–25% of ischemic strokes.[2] Despite their relatively lower prevalence, PCS are frequently associated with severe outcomes, particularly due to brainstem involvement, and often present with subtle or atypical symptoms, making early diagnosis and timely intervention a clinical challenge.

There is growing recognition that anterior and PCS differ not only in terms of anatomical involvement but also in their underlying pathophysiology and associated risk factors. Studies from East Asian countries such as China and South Korea have highlighted important distinctions. PCS tends to be more frequently associated with metabolic disorders, including hypertension and diabetes mellitus, and often involves intracranial atherosclerosis (ICAS).[3,4] In contrast, ACS has been more strongly linked to traditional atherosclerotic risk factors such as smoking, dyslipidemia, and extracranial carotid artery disease.[5] These differences have implications for both diagnostic approaches and secondary prevention strategies.

However, data from the Indian subcontinent—particularly from hospital-based settings—remain limited. Given India's dual burden of communicable and noncommunicable diseases and a high prevalence of metabolic syndrome, understanding stroke subtype-specific risk factor patterns is of critical importance. Prior studies have largely focused on stroke as a homogeneous entity, often overlooking the nuances that differentiate ACS and PCS in terms of etiology, clinical profile, and vascular pathology.

The present study was conducted to address this knowledge gap by systematically comparing modifiable vascular risk factors, specifically hypertension, diabetes, dyslipidemia, smoking, and metabolic syndrome, between anterior and posterior circulation stroke patients in a tertiary care center in Western India (Fig. 1). We also sought to assess the distribution of intracranial vs extracranial atherosclerotic disease in these two subtypes, given the potential impact of vascular territory on stroke mechanisms and outcomes.

By delineating these patterns in our patient population, we aim to contribute toward a more refined understanding of stroke subtypes in the Indian context. Such insights could facilitate more targeted prevention strategies and individualized risk factor modification, ultimately improving stroke-related outcomes in this high-risk population.

Methods

This hospital-based observational study was conducted in the Department of Internal Medicine at a tertiary care hospital over a 1-year period from January to December 2021. The study was approved by the Institutional Ethics Committee (IEC) (Approval No. IEC/MPGMCJ/2020/179, dated December 15, 2020). Written informed consent was obtained from all participants or their legally authorized representatives prior to inclusion in the study. All procedures were conducted in accordance with the ethical standards of the institutional review board and the Declaration of Helsinki.

We prospectively included consecutive adult patients (aged ≥18 years) who presented with acute stroke, either ischemic or hemorrhagic, confirmed by contrast-enhanced computed tomography (CECT) of the brain with CT angiography. Patients were included if their clinical presentation was consistent with either anterior or posterior circulation involvement and if basic vascular risk factor data were available.

Patients were excluded if they had traumatic intracranial hemorrhage, known

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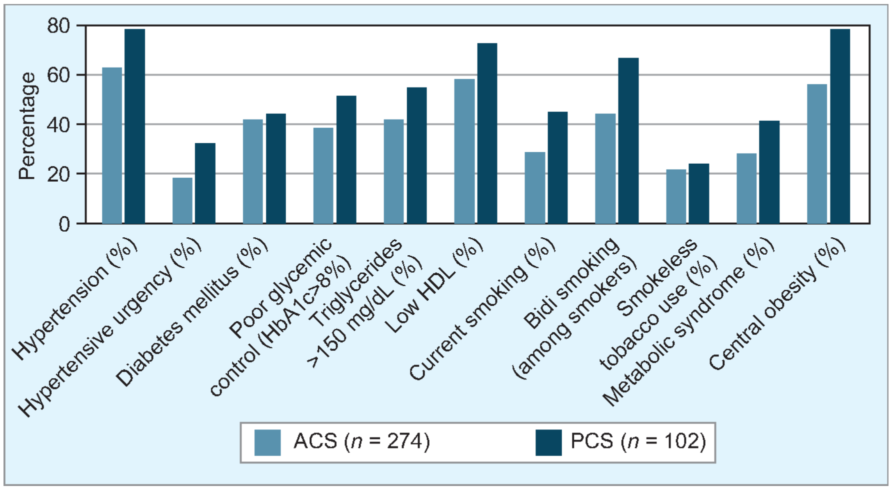

Fig. 1: Comparative prevalence of vascular risk factors in anterior vs posterior circulation stroke

Table 1: Baseline demographic and clinical characteristics of patients with ACS and PCS

Variable	*ACS (n = 274)*	*PCS (n = 102)*	*p-value*
Mean age (years)	61.2 ± 11.8	54.6 ± 10.3	0.003
Age <55 years (%)	25.10	34.60	0.04
Male sex (%)	64.20	58.80	0.34
NIHSS score, median (IQR)	8 (4–14)	5 (2–9)	0.01

cardioembolic stroke sources, such as atrial fibrillation or significant valvular heart disease, terminal illness with poor survival prognosis, or incomplete clinical documentation.

All enrolled patients underwent a structured clinical evaluation, including assessment using the National Institutes of Health Stroke Scale (NIHSS) on admission.[6] Stroke diagnosis and classification were based on CECT of the brain, supplemented by CT angiography of the intracranial and neck vessels to assess vascular territory involvement and underlying arterial pathology. This was performed using a Siemens 16-slice scanner, with findings reviewed by both a radiologist and the treating physician. Standard laboratory investigations were obtained for all patients, including complete blood count, kidney function tests, coagulation profile, fasting blood glucose, HbA1c, lipid profile, renal function tests, and serial blood pressure measurements during hospital stay.

Strokes were classified as ACS if the infarct or hemorrhage involved the territory of the middle cerebral artery (MCA) or anterior cerebral artery. PCS were defined as those affecting the vertebrobasilar system, including the brainstem, cerebellum, or posterior cerebral artery territory.[7]

Risk factors were defined in accordance with established international guidelines. Hypertension was defined as a previously known diagnosis or a systolic blood pressure ≥130 mm Hg and/or diastolic blood pressure ≥80 mm Hg, measured on at least two separate occasions during hospitalization.[8] Diabetes mellitus was defined by a documented prior diagnosis, use of antidiabetic medications, or a fasting plasma glucose ≥126 mg/dL, 2-hour plasma glucose ≥200 mg/dL, A1C ≥6.5%, or random plasma glucose ≥200 mg/dL in a patient with classic symptoms of hyperglycemia or hyperglycemic crisis.[9] Dyslipidemia was defined as total cholesterol level >200 mg/dL and/or low-density lipoprotein (LDL) cholesterol >130 mg/dL.[10] Current smoking was defined as the use of any tobacco products (smoked or smokeless) within the preceding 6 months.

Statistical analysis was carried out using IBM SPSS Statistics version 23. Continuous variables were expressed as mean ± standard deviation and compared between groups using the independent-samples *t*-test. Categorical variables were compared using the Chi-squared test. A two-tailed *p*-value of <0.05 was considered statistically significant.

Results

A total of 487 consecutive patients with acute stroke were screened during the study period from January 2021 to December 2022 at Guru Gobind Singh Government Hospital, Jamnagar. After applying the study's inclusion and exclusion criteria, 376 patients were included in the final analysis. The mean age of the cohort was 58.4 ± 12.7 years, with a male predominance (62.5%). Of these, 274 patients (72.9%) had ACS, while 102 (27.1%) were diagnosed with PCS. Baseline demographic and clinical characteristics of the study population are summarized in Table 1.

Patients with ACS were significantly older than those with PCS (61.2 ± 11.8 vs 54.6 ± 10.3 years; $p = 0.003$). Age distribution in ACS showed a unimodal peak between 55 and 70 years (58.4%), whereas PCS demonstrated a bimodal pattern, with peaks in the 45–55-year group (38.2%) and in those aged over 65 years (31.4%). Both subtypes showed male predominance (ACS: 64.2%, PCS: 58.8%; $p = 0.34$), though not statistically significant. Among PCS patients, women presented at a younger age (mean 52.4 years) than men (mean 56.1 years), suggesting possible gender-related differences in risk exposure or pathogenesis.

Hypertension was the most common vascular risk factor and was significantly more prevalent among PCS patients (78.4%) compared to ACS (62.8%; $p = 0.008$). Mean systolic blood pressure at admission was higher in PCS (158.6 ± 24.3 mm Hg) than in ACS (146.2 ± 22.1 mm Hg; $p < 0.001$). Hypertensive urgency (SBP >180 mm Hg or DBP >110 mm Hg) was observed more frequently in PCS (32.4 vs 18.2%; $p = 0.007$), indicating a more labile blood pressure profile among posterior circulation stroke patients. A detailed comparison of vascular risk factors between ACS and PCS is presented in Table 2.

Diabetes mellitus was seen in 42.3% of the total cohort, with no significant difference in prevalence between ACS and PCS groups ($p = 0.68$). However, poor glycemic control (HbA1c > 8%) was significantly more frequent in PCS (51.2 vs 38.6%; $p = 0.04$), suggesting a stronger link between uncontrolled diabetes and posterior circulation pathology.

Dyslipidemia was highly prevalent overall (68.6%), but certain lipid abnormalities were more common in PCS. Triglycerides >150 mg/dL were noted in 54.9% of PCS vs 42.3% of ACS patients ($p = 0.03$), while low high-density lipoprotein (HDL) levels were also more frequent in PCS (72.5 vs 58.4%; $p = 0.01$). These findings support a more pronounced metabolic dysregulation in patients with PCS.

Tobacco use, particularly current smoking, was significantly higher among PCS patients (45.1%) compared to ACS (28.8%; $p = 0.002$). Bidi smoking specifically showed a strong association with PCS [66.7% among PCS smokers vs 44.1% in ACS; odds ratio (OR) 2.34, 95% CI: 1.42–3.86]. The prevalence of smokeless tobacco use was similar between groups (PCS: 23.5%, ACS: 21.5%; $p = 0.68$).

Metabolic syndrome, defined by International Diabetes Federation (IDF) criteria, was present in 41.2% of PCS and 28.5% of ACS patients ($p = 0.02$). Central (abdominal)

Table 2: Comparison of vascular risk factors between with ACS and PCS patients

Risk factor	*ACS (n = 274)*	*PCS (n = 102)*	*p-value*
Hypertension (%)	62.80	78.40	0.008
Systolic BP (mm Hg, mean ± SD)	146.2 ± 22.1	158.6 ± 24.3	<0.001
Hypertensive urgency (%)	18.20	32.40	0.007
Diabetes mellitus (%)	42.30	44.10	0.68
Poor glycemic control (HbA1c >8%)	38.60	51.20	0.04
Triglycerides >150 mg/dL (%)	42.30	54.90	0.03
Low HDL (%)	58.40	72.50	0.01
Current smoking (%)	28.80	45.10	0.002
Bidi smoking (among smokers) (%)	44.10	66.70	0.001
Smokeless tobacco use (%)	21.50	23.50	0.68
Metabolic syndrome (%)	28.50	41.20	0.02
Central obesity (%)	56.30	78.40	0.001

Table 3: Presenting neurological symptoms and signs in ACS and PCS

Clinical feature	*ACS (n = 274)*	*PCS (n = 102)*	*p-value*
Hemiparesis (%)	92.70	37.30	<0.001
Aphasia (%)	48.20	12.70	<0.001
Facial palsy (%)	64.20	29.40	<0.001
Vertigo/dizziness (%)	22.60	78.40	<0.001
Ataxia (%)	18.60	62.70	<0.001
Visual disturbances (%)	9.50	54.90	<0.001
Isolated headache (%)	3.30	18.60	<0.001

Table 4: In-hospital outcomes and prognosis in ACS vs PCS patients

Outcome	*ACS (n = 274)*	*PCS (n = 102)*	*p-value*
Length of stay (days, mean ± SD)	7.2 ± 3.1	5.8 ± 2.7	0.04
mRS 0–2 at discharge (%)	42.30	58.80	0.008
In-hospital mortality (%)	8.40	6.90	0.62
Brainstem death (among PCS) (%)	–	83.3 of PCS deaths	–

Table 5: Multivariate logistic regression analysis for predictors of PCS

Predictor variable	*Adjusted OR (95% CI)*	*p-value*
Hypertension	2.34 (1.42–3.85)	<0.01
Current smoking	1.98 (1.22–3.21)	<0.01
Bidi smoking (among smokers)	2.34 (1.42–3.86)	<0.01
Age <55 years	1.76 (1.12–2.78)	0.02
Metabolic syndrome	1.65 (1.08–2.52)	0.03

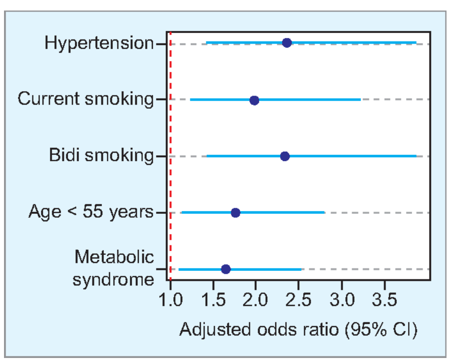

Fig. 2: Forest plot showing adjusted OR with 95% confidence intervals for independent predictors of posterior circulation stroke: hypertension, smoking, bidi smoking, age <55 years, and metabolic syndrome. OR >1 indicates higher likelihood of PCS

obesity was the most common metabolic component in PCS (78.4%), while hypertension was the most frequent component in ACS (92.6% of those with metabolic syndrome), indicating distinct cardiometabolic clustering based on stroke subtype.

Figure 1 illustrates the comparative prevalence of major vascular risk factors between anterior and posterior circulation stroke patients.

Neurological presentation differed significantly. ACS patients most frequently presented with hemiparesis (92.7%), facial palsy (64.2%), and aphasia (48.2%). PCS patients commonly presented with vertigo or dizziness (78.4%), ataxia (62.7%), and visual field disturbances (54.9%). Isolated headache was more common in PCS (18.6%) compared to ACS (3.3%; $p < 0.001$). Stroke severity at presentation was lower in PCS, as reflected by median NIHSS scores [PCS: 5 (IQR 2–9), ACS: 8 (IQR 4–14); $p = 0.01$]. The distribution of presenting neurological symptoms and signs in ACS and PCS is detailed in Table 3.

Neuroimaging findings showed that MCA territory infarcts predominated in ACS (86.5%). Hemorrhagic transformation was noted in 12.4% of ACS and 5.9% of PCS patients ($p = 0.06$). Among PCS patients, cerebellar infarcts were most common (42.2%), followed by brainstem infarcts (38.2%) and multifocal posterior circulation infarcts (19.6%).

The PCS patients had shorter hospital stays compared to ACS (5.8 ± 2.7 vs 7.2 ± 3.1 days; $p = 0.04$). Functional outcomes at discharge, measured by modified Rankin Scale (mRS), were more favorable in PCS, with 58.8% achieving an mRS of 0–2 compared to 42.3% in ACS ($p = 0.008$). In-hospital mortality rates were similar (ACS: 8.4%, PCS: 6.9%; $p = 0.62$); however, brainstem involvement accounted for 83.3% of deaths in PCS. In-hospital outcomes and discharge functional status are summarized in Table 4.

Subgroup analysis showed that younger patients (<45 years) had a higher proportion of PCS (34.6%) compared to older patients (25.1%; $p = 0.04$). In this age-group, current smoking was a particularly strong predictor of PCS (OR 3.12; 95% CI: 1.88–5.18). Gender-specific analysis revealed that women with PCS had a higher prevalence of metabolic syndrome (52.4%) compared to men (34.1%; $p = 0.03$), while smoking was significantly more common in men with PCS ($p = 0.008$), suggesting sex-specific risk factor clustering.

In multivariate logistic regression analysis (Fig. 2), four independent predictors of posterior circulation stroke emerged: hypertension (adjusted OR 2.34; 95% CI: 1.42–3.85; $p < 0.01$), current smoking (OR 1.98; 95% CI: 1.22–3.21; $p < 0.01$), age <55 years (OR 1.76; 95% CI: 1.12–2.78; $p = 0.02$), and metabolic syndrome (OR 1.65; 95% CI: 1.08–2.52; $p = 0.03$). These findings underscore the distinct clinical, metabolic, and vascular profiles that characterize posterior circulation stroke in this Indian cohort. The full multivariate logistic regression model is presented in Table 5.

Discussion

In this hospital-based cohort from Western India, we systematically compared ACS and PCS through a comprehensive analysis of demographic factors, vascular risk profiles, clinical presentations, neuroimaging characteristics, and outcomes. Notably, our findings demonstrated that PCS patients were younger, more hypertensive, more likely to be current smokers (especially bidi users), and had a higher prevalence of metabolic syndrome compared to those with ACS. This aligns with prior work showing that risk factors are not equally distributed across stroke subtypes and vascular territories.[11–13]

Age and Gender Differences

Our study showed a younger mean age in PCS patients (54.6 vs 61.2 years in ACS), with a significant proportion (34.6%) being under 55 years. This younger age profile is clinically important, underscoring the growing burden of stroke in productive-age adults in India. Similarly, females with PCS presented at a younger age than males, consistent with gender-specific risk factor clustering found in some Chinese studies.[14] These demographic nuances emphasize the need for demographic-tailored prevention efforts.

Hypertension and Blood Pressure Patterns

Hypertension emerged as a powerful predictor of PCS, both in univariate and multivariate analyses. PCS patients had a significantly higher admission systolic blood pressure and greater frequency of hypertensive urgency. Analogous findings have been observed in Chinese and Korean cohorts, where hypertension was characterized as an independent predictor of posterior circulation stroke. The strong association between elevated diastolic pressure and ICAS has also been shown in ICAS patients, supporting the hypothesis that labile hypertension may preferentially damage smaller posterior vessels.[15–17]

Metabolic Syndrome and Dyslipidemia

Our data highlighted significant metabolic dysregulation in PCS patients, evidenced by higher rates of low HDL (72.5%) and hypertriglyceridemia (54.9%), along with increased metabolic syndrome prevalence (41.2 vs 28.5%). These findings echo those in East Asian cohorts where metabolic syndrome was more tightly associated with ICAS in PCS.[18] The higher triglyceride levels and central obesity in our PCS group reinforce a metabolic–atherosclerotic pathway driving these strokes.

Tobacco Use

Tobacco, particularly bidi smoking, was significantly overrepresented in PCS patients. The adjusted OR for PCS in smokers was ~2, with even stronger associations in the younger age subgroup (OR = 3.12). These observations align with population-based studies such as those from Canadian stroke registries, which identified smoking as an important independent risk factor for PCS.[19] Given the higher toxic load and vascular damage from bidis, these findings have particular relevance in South Asian settings where these are commonly used.

Clinical and Neuroimaging Features

We confirmed that PCS often presents with nonlateralizing symptoms such as dizziness, ataxia, and headache, symptoms often misinterpreted as benign, contributing to diagnosis delays. Despite having lower NIHSS scores, PCS patients frequently showed cerebellar, brainstem, or multifocal infarcts on CT. This pattern mirrors findings from both East Asian and Western ICAS registries, where posterior intracranial plaques were prone to adventitia hemorrhage and branch occlusion, complicating clinical recognition and influencing outcomes.[20]

Outcomes and Predictors of Posterior Circulation Strokes

The PCS group had shorter hospital stays and better functional outcomes at discharge (mRS 0–2: 58.8 vs 42.3%). Mortality rates were similar between subtypes, but deaths in PCS predominantly occurred due to brainstem infarction. Notably, multivariate regression identified hypertension, smoking, younger age (<55), and metabolic syndrome as independent predictors of PCS, reflecting a distinct risk profile. These predictors are similar to those reported in multicenter ICAS/ECAS registries, which call for circuit-specific stroke prevention strategies.[14,18]

Clinical Implications

Our findings reinforce that stroke prevention cannot be a "one-size-fits-all" strategy. Prevention of PCS in India, particularly among younger individuals, should be prioritized. Priority should be on aggressive blood pressure control, metabolic syndrome management, and targeted antismoking campaigns, especially for bidi users. Early recognition of atypical symptoms such as vertigo and ataxia is also essential for timely intervention.

Study Limitations

This single-center study using CT (not MRI) may miss small posterior infarcts, and the absence of formal intracranial angiography limits direct classification of ICAS vs ECAS. However, our reliance on initial CT and clinical criteria reflects real-world stroke evaluation in many Indian centers.

Future Directions

Further multicentric studies integrating MR brain and MR angiographic imaging are needed to directly compare ICAS vs ECAS in Indian populations and elucidate genetic predispositions. Additionally, the long-term impact of targeted risk factor modification needs assessment, particularly in younger adults with PCS.

Conclusion

This study demonstrates that PCS differ significantly from ACS in terms of demographics, clinical presentation, and risk factor profile. PCS was more common in younger patients and independently associated with hypertension, smoking, metabolic syndrome, and poor glycemic control. Despite lower NIHSS scores, PCS often presents with atypical symptoms and brainstem or cerebellar involvement. Functional outcomes were better in PCS, though brainstem infarcts carried a high mortality. These findings emphasize the need for territory-specific risk stratification and targeted prevention strategies, particularly in younger, high-risk populations.

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