Posterior Circulation Ischemic Stroke—Clinical Characteristics, Risk Factors, and Subtypes in a North Indian Population: A Prospective Study

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Abstract

Background and Purpose: Posterior circulation stroke accounts for approximately 20% of all strokes with varied clinical presentation, which differ from strokes in anterior circulation, with reference to etiology, clinical features, and prognosis. Short penetrating and circumferential branches in the posterior circulation supply the brain stem, thalamus, cerebellum, occipital, and medial temporal lobes. **Materials and Methods:** We prospectively analyzed 80 participants of posterior circulation ischemic stroke from a registry of 944 participants attending a tertiary care referral university hospital. Patients were analyzed for demographics, stroke risk factors, clinical characteristics, neuroimaging, and stroke subtypes. **Results:** Posterior circulation ischemic stroke accounted for 80 (8.5%) of 944 of all strokes and 80 (10.45%) of 765 of ischemic stroke. Sixty-three were males with mean age 51.7 ± 14.4 years. Twenty-one participants were young (defined as age less than 45 years). Hypertension was found to be the most common risk factor (63.75%). Vertigo was the most common clinical symptom reported in 45 (56.25%) cases. Sixty-eight (85%) patients had large artery disease, 8 (10%) had documented cardioembolic source, 3 (3.75%) small artery disease, and 2 (2.5%) vasculitis. Posterior cerebral artery was most commonly involved. Topographically distal intracranial involvement was most frequent (66.25%) followed by proximal (30%) and middle intracranial territory (3.75%). **Conclusions:** Our study demonstrated the occurrence of posterior circulation stroke in relatively younger age group compared to the Western world. We also found higher percentage of large artery disease, while cardioembolism as a less frequent cause of posterior circulation ischemic stroke in North Indian population. Distal territory involvement was most common in our study.

Keywords

posterior circulation stroke, stroke subtypes, risk factors

Introduction

The posterior circulation consists of the 2 vertebral arteries, basilar artery, 2 posterior cerebral arteries, and their branches.¹ This is the only vascular region in the body where 2 arteries unite to form a large arterial trunk that again divides in 2 major branches. These arteries, through short penetrating and circumferential branches, supply the brain stem, thalamus, cerebellum, occipital, and medial temporal lobes.¹ Posterior circulation stroke can have diverse presentations that differ from strokes in anterior circulation in relation to etiology, clinical features, and prognosis. Posterior circulation stroke can present with vertigo, ataxia, vomiting, headache, cranial nerve abnormalities, bilateral long tract neurological sign, “locked in” syndrome or impaired consciousness, and complex ocular signs or cortical blindness. The intracranial portion of posterior circulation is much more prone to atherosclerosis as compared

to anterior circulation. Posterior circulation strokes account for approximately 20% of all strokes, with high mortality and morbidity,² although few studies revealed low mortality rate among patients with vertebrobasilar territory infarcts.^{3,4} To the best of our knowledge, there is no study from North India, which systematically analyzed posterior circulation ischemic stroke defining risk factors, vascular territory involvement, infarct location, and clinical characteristics. We report on 80 patients with posterior circulation ischemic stroke.

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Methods and Data Analysis

We describe 80 participants with posterior circulation ischemic stroke from a registry of 944 participants attending a tertiary care referral university hospital. Patients were identified for the stroke registry based on daily review of admission logs. Ethics approval was obtained from the institute committee on human research.

Out of a total of 944 patients with stroke, 87 (9.2%) had clinical manifestations suggestive of posterior circulation ischemia. Seven were excluded due to inadequate clinical and neuroimaging records. Patients with transient ischemic attack (TIA) and concomitant anterior circulation infarction were not included in the study. Patients were analyzed using structured pro forma for (1) demographics, and stroke risk factors including hypertension, diabetes mellitus, smoking, alcohol consumption, obesity, dyslipidemia, cardiac diseases, migraine, oral contraceptive use, neck trauma hyperhomocystinemia, and antiphospholipid antibody syndrome; (2) clinical characteristics, results of neuroimaging and vascular studies describing infarct location and vascular territory involvement. Hypertension was defined per the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC) VI and JNC VII criteria during the respective period of registry.^{5,6} Diabetes mellitus was defined according to the ADA guideline of elevated fasting blood glucose ≥ 126 mg% or HbA1c $\geq 7\%$ or previously on oral hypoglycemic or insulin injections.⁷ Dyslipidemia was defined using the National Cholesterol Education Programme–Adult Treatment Panel III (NCEP-ATP III) criteria as serum triglyceride concentration of >150 mg%, cholesterol concentration of >200 mg%, and or high-density lipoprotein concentration of <40 mg% in males and less than 50 mg% in females.⁸ Patients having body mass index more than 25 kg/m² were considered obese.⁹ Smoking was defined as usage of more than 10 cigarettes/d for more than 1 year and Consumption of ≥ 30 g of ethanol per day were labeled as alcoholic. Participants who did not have any common risk factors like hypertension, diabetes, atrial fibrillation, or other cardiac illness were investigated for serum homocysteine level and antiphospholipid assay during the acute phase and subjected for repeat testing at 3 months after stroke. Fluorescence polarization immunoassay technique was used for serum homocysteine level and enzyme immunoassay method for antiphospholipid antibody detection.

All patients were subjected to computerized tomography (CT) scan, and or magnetic resonance imaging (MRI) following standard protocol. Magnetic resonance imaging could not be done in all cases because of nonaffordability of patients to bear the cost of the scan. Extracranial and intracranial vessels were evaluated with carotid Doppler and extracranial and intracranial magnetic resonance angiography (MRA) in selected patients. Infarct location was decided by clinical assessment and by neuroimaging findings. The stroke events were classified according to the Trial of Org 10172 in Acute Stroke Treatment (TOAST) classification.¹⁰ The categories included (1) large-vessel atherosclerosis: atherosclerosis with

stenosis; (2) small-vessel disease: lacunar syndrome and normal CT/MRI or relevant lesion <1.5 cm and absent source of emboli; (3) cardioembolism; (4) other determined causes; and (5) undetermined causes: 2 or more causes identified, negative evaluation, or incomplete evaluation.

Patients were classified into 5 subgroups according to the vascular territory involvement and distribution of infarcts on neuroimaging. These subgroups included posterior cerebral artery, superior cerebellar artery, anterior inferior cerebellar artery (AICA), posterior inferior cerebellar artery (PICA), and top of basilar artery. Patients were also categorized according to proximal–distal extent of infarction as “proximal intracranial” (vertebral artery-medulla; PICA-cerebellum), “middle intracranial” (basilar artery-Pons; AICA-cerebellum) and “distal intracranial” (rostral basilar artery-midbrain, thalamus; superior cerebellar artery-cerebellum; posterior cerebral artery-occipital and medial temporal lobe.⁴

Results

In the present study posterior circulation ischemic stroke accounted for 9.2% of all strokes and 11.37% of ischemic stroke.

Demographic Profile and Risk Factors

Among the 80 patients, 63 were males with a mean age of 51.7 ± 14.4 years. Twenty were young (defined as 15–45 years old) with a mean age of 33.15 ± 7.2 years. Other demographic features and risk factors are shown in Table 1.

Clinical Characteristics of Posterior Circulation Stroke

Vertigo was the most common clinical symptoms present in 45 (56.25%) cases. Table 2 lists other clinical manifestations.

Vascular Territory and Infarct Location

Posterior cerebral artery involvement was most common ($n = 43$), followed by PICA ($n = 22$). Table 3 shows the vascular territorial distribution. Topographically, 53 had infarct location in a distal territory, 3 in a middle intracranial, and 24 involved proximal intracranial territories as shown in Table 4. Table 5 shows the etiology of vascular lesions.

Discussion

In our study, of all the strokes, 81% of strokes were ischemic, and 11.37% of these were in a posterior circulation territory. Most of the other studies have reported that 80% of strokes are ischemic and 20% of ischemic strokes involve the posterior circulation.¹¹ The Lausanne Stroke Registry¹² and the Besancon Stroke Registry¹³ revealed the relative prevalence of posterior circulation stroke to be 26.7% and 26%, respectively. Hallym Stroke Registry (HSR) showed that posterior circulation stroke was responsible for 39.8% of all ischemic

Table 1. Demographic Profile and Risk Factors of 80 Patients With Posterior Circulation Stroke

Variable	Frequency, n	Percentage
Demographics		
Male	63	78.8
Age (years)	(Mean = 51.7 years $\pm$ 14.4)	
0-20	4	5
21-40	6	7.5
41-60	52	65
61-80	18	22.5
Young stroke (15-45 years)	21	26.25
Risk factors		
Hypertension	51	63.75
Diabetes	24	30
Smoking	25	31.25
Alcohol	5	6.25
Dyslipidemia	17	21.25
Cardiac disease	18	22.5
Coronary artery disease	14	17.5
Rheumatic heart disease	2	2.5
Cardiomyopathies	2	2.5
Atrial fibrillation	1	1.25
Obesity	8	10
Chronic kidney disease	3	3.75
Hyperhomocystinemia	4	5
Antiphospholipid antibody	1	1.25
Migraine	0	—
Oral contraceptive use	0	—
Neck trauma	0	—

Table 2. Clinical Characteristics of Posterior Circulation Stroke

Clinical Characteristic	Frequency, n
Vertigo	45 (56.25%)
Ataxia	39 (48.75%)
Motor weakness	34 (42.5%)
Vomiting	33 (41.25%)
Headache	25 (31.25%)
Cranial neuropathy	21 (26.25%)
Dysphagia	19 (23.75%)
Visual symptoms	16 (20%)

strokes.¹⁴ Our study showed a relatively low prevalence of posterior circulation stroke as compared to the studies described above. Our hospital is a referral center and referral bias is likely the reason for this difference.

In our study the majority (65%) of the patients were in the age group of 40 to 60 years. The New England Medical Center Posterior Circulation Registry (NEMC-PCR) demonstrated that majority of patients with posterior circulation stroke were in age group ranging between 66-75 years.³ Stroke occurs in relatively younger people in developing countries. In our study only 3 patients (3.75%) were older than 75 years, while in NEMC-PCR 27.7% of patients were in age group ranging more than 75 years. Lower life expectancy in Indian

Table 3. Vascular Territory Involvement

Vascular Territory	Frequency, n
Posterior cerebral artery	43 (53.75%)
PICA	22 (27.5%)
SCA	9 (11.25%)
AICA	2 (2.5%)
TOB	1 (1.25%)
ICVA	2 (2.5%)
Nonlocalizable	2 (2.5%)

Abbreviations: PICA, posterior inferior cerebellar artery; AICA, anterior inferior cerebellar artery; SCA, superior cerebellar artery; TOB, top of basilar artery; ICVA, intracranial vertebral artery.

Table 4. Subdivision of Posterior Circulation Ischemic Stroke According to Rostral Caudal Location of Infarct

Infarct Location	Frequency
Distal	53 (66.25%)
Middle	3 (3.75%)
Proximal	24 (30%)

Table 5. Subtypes of Posterior Circulation Ischemic Stroke According to TOAST Criteria

Stroke Subtype	No. of Patients
Large artery disease	61 (76.25%)
Small-vessel disease	3 (3.75%)
Cardioembolic stroke	8 (10%)
Other determined causes	2 (2.5%)
Undetermined causes	6 (7.5%)

population compared to the Western world (66.46 vs 78.24 years) could be the explanation for this difference. In Table 6, we compared our results with other studies regarding the risk factors for posterior circulation stroke.

Posterior circulation stroke can have varied clinical presentations. Vertigo was the most common clinical finding in our study, reported in 56.25% of patients. Vertigo in posterior circulation stroke is due to the involvement of vestibular nucleus or its connections. Vertigo is a predominant feature of lateral medullary syndrome and cerebellar stroke especially due to PICA and AICA territory involvement. Due to the high density of nuclei and tracts in the brain stem, vertigo is usually accompanied by the involvement of other cranial nerves and or long tracts. It has been reported that isolated episodes of vertigo continuing for more than 3 weeks are almost never caused by vertebra-basilar disease.¹¹

Ataxia was the second most common manifestation (48.75%) in our study. Ataxia in posterior circulation stroke is due to the involvement of cerebellum or its connections. Our study showed vomiting in 41% and headache in 31% of cases. In posterior circulation stroke headache and vomiting are more frequently seen than in anterior circulation strokes.¹⁸⁻²¹ Fisher reported that headache in anterior

Table 6. Comparison of Risk Factors Among Various Studies on Posterior Circulation Stroke

Risk factors	Our Study	NEMC-PCR ¹⁵	Lee et al ¹⁴	Uma et al ¹⁶	Kora ¹⁷
Hypertension	51	61	69.9	21	37
Diabetes	24	25.4	30.2	35.5	05
Smoking	25	35.7	32.4	35.5	–
Alcohol	05	31.1	–	19.7	21
Dyslipidemia	17	24.7	24.2	44.4	10
Coronary artery disease	14	34.7	–	17.1	05
Rheumatic heart disease	02	–	–	10.5	05
Cardiomyopathies	02	–	–	–	–
Atrial fibrillation	01	–	–	–	–
Obesity	08	17.3	–	–	–
Migraine	0	11.5	–	11.8	–
Oral contraceptive use	0	12.5	–	39.1	–

Abbreviation: NEMC-PCR, New England Medical Center Posterior Circulation Registry.

circulation strokes is generally frontal, usually ipsilateral to the lesion, while posterior circulation stroke headache tended to be occipital.²² A proposed explanation for this difference is that the cerebral vasculature of the meninges in the posterior circulation is more heavily innervated by nociceptive afferents than the anterior circulation.²³ Vomiting may occur due to the involvement of vestibular nucleus or chemoreceptor trigger zone (CTZ). Motor weakness was seen in 42.5% of our cases.

A study from China by Shi et al²⁴ that analyzed clinical characteristics in 216 patients with posterior circulation stroke found dizziness in 33.8% and ataxia in 30%, which were less as compared to our observations. The above-mentioned study also demonstrated a relatively higher percentage of patients with motor weakness (81.9%) as compared to our study. This difference might have been because fewer patients had mid-brain and pontine infarctions in our study. Among our 43 cases with posterior cerebral artery infarct 16 (37.2%) had visual field defect or visual loss. The NEMC-PCR showed visual field loss in 84% of patients with posterior cerebral artery infarct.²⁵ The above described clinical variations might have been due to different infarct location, size and vascular territory involvement in different study groups.

In our study, 76% patients had large artery disease and 10% had a documented cardioembolic source. Large artery disease was present in 32% of patients in NEMC-PCR, while 40% had embolic cause out of which 24% had cardiac source of embolism. Higher incidence of large artery involvement in our study could be due to the more frequent intracranial large artery atherosclerosis in Asians compared to whites.^{26–28} In HSR, 5.2% of the patients had cardioembolism, and the most frequent stroke subtype was large artery disease (50%).¹⁴ Only 1 patient in our study had atrial fibrillation.

Distal infarct location was most common in our study, reported in 66.25% of patients followed by proximal location seen in 30% of cases. Only 3 (3.75%) had middle intracranial infarct location. The NEMC-PCR also reported distal infarction as the most common location (40.9%). Although in comparison to the NEMC registry, our study revealed lower

occurrence in the middle intracranial location. Uma et al also showed a predominance of distal intracranial (46%), followed by proximal intracranial (34%), vascular distribution in the posterior circulation stroke.¹⁶ In HSR, the most common infarct location was in the middle territory (36.5%) followed by distal, proximal, and multiple territory. Different stroke etiology might have been responsible for these differences in infarct locations.

There are a number of lacunae in our study. This may not reflect the true picture of posterior circulation stroke in a general hospital and community since ours is a referral hospital and there may be referral bias.

Conclusions

This study from North India describes the pattern of risk factors, clinical characteristics, and stroke subtypes of posterior circulation ischemic stroke. Our study demonstrated the occurrence of posterior circulation stroke in a relatively younger age group compared to case series from the Western world. We found a higher percentage of large artery disease, and cardioembolism as a less frequent cause of posterior circulation ischemic stroke in a North Indian population. Distal territory involvement was most common in our study. Our data suggest that etiology, risk factors, stroke subtypes, and lesion topography in posterior circulation strokes can have regional, environmental, and ethnic variations.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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