International Journal of Medical Research Professionals
P-ISSN: 2454-6356; E-ISSN: 2454-6364
DOI: 10.21276/ijmrp

Original Research Article.

Assessment of Ischemic Stroke Subtypes Using MR Angiography in North Indian Population

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ABSTRACT

Introduction: Stroke is a major global public health problem and is becoming a leading cause of death and disability in developing countries, afflicting individuals even at young age. There are various subtypes of stroke, each associated with particular set of risk factors and site of pathology. Defining the location and extent of vascular compromise greatly aids in selection of the appropriate therapy with the treatment being subtype specific.

Aims and Objectives: To study the pattern and site of ischemic stroke subtype using Magnetic resonance angiography in patients of ischemic stroke.

Methods: An observational cross-sectional study was conducted in Medicine department at Rajindra hospital, Govt. Medical College Patiala involving patients presenting with ischemic stroke. This study group will include all the patients >18 years of age. Patients were followed up with MR Angiography to assess the site of blockade.

Results: Intracranial large vessel occlusion (LVO) was the most frequent subtype (~80%), while extracranial disease formed only 4% of cases. Small vessel occlusion (SVO) contributed 22%, frequently associated with chronic hypertension. Dual pathology (LVO+SVO) seen in 3% indicates overlapping vascular mechanisms. MCA territory was most commonly affected (84%) confirming its hemodynamic vulnerability. Hypertension and smoking emerged as significant risk factors with distinct vascular patterns- hypertension for SVO, smoking for extracranial disease.

Keywords: Ischemic Stroke, MR Angiography, Vessel Occlusion.

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Article History:
Received: 23-12-2025, **Revised:** 20-01-2026, **Accepted:** 30-01-2026

Access this article online	
Website: www.ijmrp.com	Quick Response code
DOI: 10.21276/ijmrp.2026.12.1.002	

INTRODUCTION

Stroke, a time sensitive medical crisis, is defined as the abrupt onset of focal neurological deficit attributable to a focal vascular cause. Globally, it stands as a significant contributor of mortality and prolonged disability.[1] Burden of stroke is equally alarming in developing countries like India. The prevalence of stroke in India is estimated to be 200-300 per 1,00,000 people with significant variations in incidence and outcomes across different regions. The prevalence in north India is similar to national average.[2]

Stroke is broadly classified into two main categories: ischemic and haemorrhagic. Ischemic stroke is the predominant form, constituting nearly 85% of all strokes. Ischemic stroke is quite heterogenous in pathophysiological mechanisms and this forms the basis of stroke subtyping done according to TOAST classification. Additionally, current guidelines for stroke prevention and treatment are subtype specific. Previous literature suggested that intracranial atherosclerotic disease was more predominant in eastern population while extracranial disease, prevalent in whites, was quite rare in eastern population.[3]

MR angiography offers thorough visualisation of both intracranial and extracranial vasculature, enhancing the precision of stroke subtyping in Asian and western population, facilitating personalised treatment strategies and advanced stroke research.

AIMS AND OBJECTIVES

To study the pattern of ischemic stroke subtypes using MR angiography in patients of ischemic stroke.

MATERIALS AND METHODS

This was a cross-sectional study of ischemic stroke patients presenting in RHP, Patiala.

All eligible patients who visited RHP during the study period from August 2023 to July 2024 were enrolled. So, a sample size of 100 patients was selected for the study. After ruling out haemorrhage on NCCT Head, MRI Brain with Angiography using TOF sequence was done to identify the involved vessel in all patients. Data was collected in predefined questionnaire and data was analysed.

Inclusion Criteria

1.Patients with symptoms of ischemic stroke
2.Confirmed by radiological studies as ischemic stroke
3.Patients above 18 years age

Exclusion criteria

1.Haemorrhagic stroke
2.TIA
3.patients below 18 years age
4.Pregnancy and lactation
5.Liver failure
6.Renal failure
7.concomitant sepsis
8.Patients with shock
9.Contraindication for MRI
10. Refusal for consent

RESULTS AND OBSERVATIONS

The study evaluated a total of 100 ischemic patients. The majority of participants were aged 61-70 years (35%), with mean age of 62.14+-13.83 years. Males comprised 57% of the sample. Common comorbidities included hypertension (59%) and diabetes (26%) with older age group predominance especially among females. (Table 1)

The most common site of occlusion was MCA (54%), followed by PCA (24%). Small vessel obstruction accounted for 22% of cases. ACA and ICA obstructions were less frequent, observed in 6% and 2% respectively. (Table 2)

The vast majority of strokes were intracranial, indicating their higher prevalence as compared to extracranial stroke which was observed only in 4% population. (Table 3)

Hypertension and diabetes were significantly more associated with large vessel obstruction compared to small vessel obstruction, with p-values of 0.015 and 0.001 respectively, indicating statistical significance. Smoking showed a higher occurrence in LVO (8%) as compared to SVO (3%), but the association was not statistically significant. (Table 4)

Table 1: Sociodemographic Profile

Sociodemographic Profile	Male	Female	Total
Age (Years)			
21-30 Years	3 (3%)	1 (1%)	4 (4%)
31-40 Years	3 (3%)	0 (0%)	3 (3%)
41-50 Years	11 (11%)	1 (1%)	12 (12%)
51-60 Years	13 (13%)	9 (9%)	22 (22%)
61-70 Years	18 (18%)	17 (17%)	35 (35%)
71-80 Years	8 (8%)	11 (11%)	19 (19%)
≥81 Years	1 (1%)	4 (4%)	5 (5%)
Mean±SD	58.25±13.93	67.30±12.02	62.14±13.83
Gender	57 (57%)	43 (43%)	100 (100%)
Diabetes	12 (12%)	14 (14%)	26 (26%)
Hypertension	32 (32%)	27 (27%)	59 (59%)

Table 2: Anatomical distribution of vessel occlusion

		Patients (%age)
Large Vessel Obstruction (LVO)	**Internal Cerebral Artery (ICA)**	2 (2%)
	Middle Cerebral Artery (MCA)	54 (54%)
	Anterior Cerebral Artery (ACA)	6 (6%)
	Posterior Cerebral Artery (PCA)	24 (24%)
Small Vessel Obstruction (SVO)		22 (22%)

Table 3: Stroke subtypes distribution

	Patients (%age)
Intracranial Stroke	96 (94%)
Extracranial Stroke	4 (4%)

Table 4: Distribution of risk factors in large vs small vessel occlusion

	Large Vessel Obstruction (LVO)	Small Vessel Obstruction (SVO)	χ2	p value
Hypertension	48 (48%)	11 (11%)	5.92	0.015 (S)
Diabetes	21 (21%)	5 (5%)	39.05	0.001 (HS)
Smoking	8 (8%)	3 (3%)	3.12	0.078 (NS)

DISCUSSION

The distribution of ischemic stroke subtypes in the North Indian population exhibits distinct patterns, influenced by regional epidemiological factors, vascular anatomy, and lifestyle determinants. This study, utilizing MRA, provides insights into the prevalence of extracranial and intracranial large and small vessel occlusions among 100 ischemic stroke patients.

The most prominent observation in this research was the high prevalence of large vessel occlusion, with 80% of patients demonstrating this subtype. This is in alignment with prior research emphasizing the dominant role of LVO in ischemic stroke pathophysiology. For instance, the Chinese Intracranial Atherosclerosis (CICAS) study and study by Goyal et al. (2016) yielded similar results.[4] The higher rate in our study may reflect a combination of genetic predisposition, late presentation to the hospital, or complex interplay of vascular risk factors like HTN and DM, all of which are common in South Asian regions and known contributors to LAA.

In contrast, studies in Western populations have often reported a slightly lower prevalence of LVO. For instance, the Northern Manhattan Stroke Study reported LVO in around 30–50% of ischemic stroke cases, with extracranial carotid stenosis and cardioembolic sources playing a more prominent role.[5] These differences highlight the importance of regional and ethnic variations in stroke etiology, and the value of local epidemiological studies like ours in informing clinical practice.

Based on the data, 22% of patients exhibited evidence of SVO, whereas 78% did not. This indicates that SVO is less prevalent in this study compared to other stroke subtypes, such as LVO. For instance, the Northern Manhattan Stroke Study reported that SVO accounted for 21–25% of ischemic strokes in their population, which is nearly identical to our finding of 22%. This suggests that, despite regional differences, SVO maintains a consistent representation among stroke subtypes across diverse populations. Our findings are more consistent with studies conducted in Asian populations, where large vessel and intracranial atherosclerotic disease are inclined to be more common, and SVO occurs relatively less frequently. [6]

SVO typically results from lipohyalinosis or microatheroma in small penetrating vessels, such as the lenticulostriate, thalamoperforating, or pontine branches. These infarcts often present as lacunar strokes, which may be missed or underreported, particularly if advanced MRI techniques like diffusion-weighted imaging (DWI) are not coupled with MRA. MRA, while excellent for visualizing larger vessels, may lack the resolution to detect small-calibre arterial occlusions accurately.

In addition, dual occlusion was noticed in 3% of patients. The coexistence of LVO and SVO in ischemic stroke patients represents a complex interplay between macrovascular and microvascular pathologies. Studies have demonstrated that both conditions share common risk factors, such as hypertension and diabetes mellitus, and often coexist in patients with ischemic stroke of undetermined cause. These findings underscore the importance of comprehensive vascular assessment in stroke patients, as the simultaneous presence of LVO and SVO may influence treatment strategies and prognostic outcomes.

Furthermore, extracranial involvement was detected in only 4% of patients, indicating that the vast majority of stroke in this research were of intracranial origin. This finding is in harmony with studies conducted in similar settings. For example, the Oxford Vascular Study reported extracranial carotid stenosis in only a minority of ischemic stroke cases. The relatively low prevalence of extracranial stroke may also reflect population-based differences, such as lower rates of atherosclerosis or disparities within risk factor profiles like smoking and hyperlipidemia.[6]

The results of this research depict a clear predominance of intracranial LVO and SVO among patients of ischaemic CVA in the Asian population, with extracranial involvement being comparatively rare. This pattern aligns with existing evidence from Asian and African populations, where intracranial atherosclerosis tends to be more prevalent than extracranial disease. This contrasts with Western populations, where extracranial carotid atherosclerosis is more commonly reported.

The study reveals that MCA stroke was the most predominant subtype, detected in 54% of patients, pursued by PCA stroke in 24%, ACA stroke in 6%, and ICA stroke in only 2% of patients. This distribution is consistent with the vascular anatomy and pathophysiology of cerebral circulation, where the MCA supplies a large share of the cerebrum, making it more susceptible to embolic and thrombotic occlusions. The high incidence is attributed to the MCA's anatomical features as it is a direct continuation of the ICA and has a larger calibre, which increases the possibility of emboli entering this artery.

PCA strokes were observed in 24% of patients, which is higher than typically reported in some Western studies but not unprecedented. Previous studies have found PCA strokes in 10–20% of cases.[7]

The frequency of ACA stroke was 6%, which is within the expected range. ACA territory infarctions are relatively rare due to presence of collateral circulation via the anterior communicating artery. For instance, according to the Lausanne Stroke Registry, ACA strokes accounted for about 1–3% of ischemic strokes.

Only 2% of patients showed direct involvement of the ICA, which is quite low. However, ICA occlusions can often induce downstream infarctions in the MCA or ACA territories.

The patients in our study were 62.14 years old on average, with a standard deviation of 13.83 years. The majority of ischemic stroke cases were observed in individuals aged 61–70 years (35%), followed by those aged 51–60 years (22%) and 71–80 years (19%). This pattern underscores the strong age-related predisposition to ischemic stroke, particularly in the elderly population. These findings are in alignment with previous literature emphasizing a significant rise in incidence of stroke in individuals above 60 years, aligning closely with our observation that over 76% of cases occurred in those aged above 50 years. [8]

Pertaining to the correlation between hypertension and LVO, our study observed a greater proportion of hypertensive patients with LVO (84.7%) compared to non-hypertensive patients (73.2%). However, there was no statistically significant correlation ($p = 0.078$), aligning with findings from other research. A study by Whelton (1994) noted that while hypertension is a well-established risk factor for CVA, its direct association with LVO remains inconclusive. [9] The lack of statistical significance in our study may be due to the complex interplay of multiple factors contributing to LVO, including age, diabetes, and lipid profiles. In addition, the presence of collateral circulation and the degree of arterial remodelling in hypertensive patients could modulate the impact of hypertension on LVO.

In contrast, our study found a statistically significant association between hypertension and SVO ($p = 0.033$). Hypertensive patients exhibited a greater prevalence of SVO compared to non-hypertensive patients. This finding is accordance with existing literature, which indicates that chronic hypertension leads to alterations in the microvasculature, such as arteriolosclerosis and lipohyalinosis, increasing the risk of SVO.

The significance of this association emphasizes the significance of managing hypertension to prevent SVO and its associated complications, including lacunar infarcts and cognitive decline.

As shown in our study of 100 patients, with 89% (89 patients) being non-smokers and 11% (11 patients) reporting a history of smoking. While smoking remains a critical contributing factor for ischemic CVA, the relatively low percentage of smokers in this study is somewhat atypical. This may reflect regional or population-specific differences in smoking behaviours.

The correlation between smoking and LVO in ischemic CVA patients was explored. Among the 100 patients, a higher percentage of smokers (72.7%) had LVO compared to non-smokers (80.9%), although this difference was not statistically significant (p-value = 0.523). The lack of a statistically significant relationship between smoking and LVO is consistent with some studies that report no strong association between smoking and LVO.

The association between smoking and SVO was examined. Among smokers, 36.4% exhibited small vessel occlusion, compared to 20.2% of non-smokers. Despite this difference, the p-value of 0.223 indicates that the relationship between smoking and SVO was not statistically significant. The lack of significant associations with SVO in this study aligns with the work of Liao et al. Previous studies have concluded that smoking can contribute to microvascular damage, potentially leading to SVO due to its effects on blood pressure, endothelial function, and clotting mechanisms.

Conversely, to the findings for LVO and SVO, this study reveals a significant association (p-value = 0.011) between smoking and extracranial vessel occlusion. Among smokers, 18.2% had extracranial vessel occlusion, whereas only 2.2% of non-smokers had this pathology. These findings aligns with earlier research that have identified smoking as a substantial risk factor for extracranial atherosclerosis and carotid artery disease, both of which can lead to extracranial vessel occlusion. Smoking accelerates atherosclerotic changes in the large arteries, contributing to the genesis of plaque and narrowing of the vessels. These changes can heighten the risk of stroke, mainly in the extracranial circulation. The significant association in this study highlights the value of addressing smoking as a modifiable risk factor for extracranial vascular disease. Similarly, a study by Wang et al. (2017) highlighted a robust relationship between smoking and extracranial vascular occlusions, supporting the results of our study. [10] The observed prevalence of 12% for cardioembolic strokes in our study aligns with previous research conducted in South India. This suggests that cardioembolic strokes represent a significant but not predominant subtype of ischemic strokes in our region. The study in South India also highlighted that older age and HTN were major risk factors of cardioembolic strokes, findings that are corroborated by our data.

Regarding the correlation between cardioembolic strokes and LVO, our study found no statistically significant association ($p = 0.758$). This is in contrast to a comprehensive analysis that reported a mean prevalence of LVO of 31.1% in patients presenting with acute stroke.

Conversely, our study demonstrated a statistically significant association between cardioembolic strokes and the absence of SVO ($p = 0.048$). This finding is in line with the understanding that cardioembolic strokes typically result from emboli originating from the heart, leading to large cortical infarcts, rather than from small vessel disease. The absence of SVO in cardioembolic strokes further supports the distinct pathophysiological mechanisms underlying this subtype.

This study explored the pattern of ischemic stroke subtypes in relation to diabetes mellitus using MRA. Diabetes is a renowned risk factor for cerebrovascular disease, contributing significantly to both macrovascular and microvascular complications. However, its precise role in determining specific ischemic stroke subtypes still is a subject of ongoing research.

In our study, 26% of patients had a history of DM, while 74% were non-diabetic. According to Sarikaya et al, diabetes contributes to endothelial dysfunction, increased atherosclerosis, and impaired cerebrovascular autoregulation, all of which predispose individuals to ischemic events.

Among diabetic patients in our study, 80.8% demonstrated LVO, compared to 73.0% in non-diabetic patients. Despite this apparent trend toward increased LVO among diabetics, the association did not reach statistical significance ($p = 0.430$). Similar findings were reported by Ntaios et al, who noted a greater percentage of large-artery atherosclerotic strokes in diabetics, although statistical significance varied across cohorts. Furthermore, Yoon et al highlighted that while diabetes was commonly associated with atherosclerotic changes, its predictive value for LVO-specific mechanisms may be influenced by co-existing conditions like HTN and dyslipidemia. [11]

Our results showed that 19.2% of diabetic patients had small vessel occlusion (SVO), compared to 23.0% among non-diabetics, again revealing no statistically significant correlation ($p = 0.692$). This finding aligns with the work of Kim and colleagues, who reported that while DM is a traditional risk factor for SVO, the overlap with different vascular risk factors often obscures isolated associations. [12]

Other studies have emphasized that chronic hyperglycemia can promote lipohyalinosis and arteriolar sclerosis, consequently increasing the risk of lacunar infarctions — the hallmark of SVO — but clear causal relationships remain inconsistent across populations.

Regarding extracranial vessel involvement, 7.7% patients had DM and 2.7% of non-diabetics had documented occlusions. Although more frequent in diabetics, this association was also not statistically significant ($p = 0.264$). Previous studies, such as the work by Yamashita et al, have documented enhanced prevalence of extracranial carotid stenosis among diabetic patients, particularly in those with poorly controlled glycaemic status. Nonetheless, our results suggest that within the scope of ischemic stroke presentation, extracranial occlusion may not be strongly influenced by diabetic status alone.

CONCLUSION

This study provides valuable insights into the distribution and characteristics of ischaemic stroke subtypes in a North Indian population, with particular emphasis on the role of Magnetic Resonance Angiography (MRA) in delineating vascular pathology.

The findings demonstrate a marked predominance of large vessel occlusion (LVO), observed in 80% of cases, underscoring the critical role of intracranial atherosclerotic disease in regional stroke epidemiology. Middle cerebral artery (MCA) infarctions were the most frequent anatomical subtype, reflecting both vascular anatomy and the hemodynamic properties of cerebral circulation.

Small vessel occlusion (SVO) was detected in 22% of patients, aligning with global prevalence estimates, but its detection may be limited by the inherent resolution constraints of MRA in identifying microvascular pathology. Extracranial vessel occlusion was relatively rare (4%), further affirming that intracranial atherosclerosis predominates in this population—a pattern contrasting with Western populations, where extracranial carotid disease is more prevalent.

Our analysis of vascular risk factors revealed notable though not always statistically significant associations. Hypertension was significantly linked to SVO ($p = 0.033$), supporting its established role in microvascular injury and lacunar infarction.

As smoking was significantly associated with extracranial vessel occlusion ($p = 0.011$), aligning with existing evidence that links tobacco use to accelerated large artery atherosclerosis. However, no statistically significant correlations were found between smoking and either LVO or SVO.

Interestingly, diabetes and cardioembolism did not show statistically significant associations with specific stroke subtypes in this study, highlighting the multifactorial nature of stroke pathophysiology. With a mean patient age of 62.14 years and a peak incidence in the 61–70 age group, this study reaffirms the age-related increase in ischemic stroke risk.

Overall, our findings underscore the predominance of intracranial LVO and MCA strokes in the studied population, with vascular risk factors—particularly hypertension and smoking—playing subtype-specific roles.

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Source of Support: Nil.

Conflict of Interest: None Declared.

Cite this article as: Chetan Goyal, RPS Sibia, Vikas Chander, Ajay Bhaskar, Shubham Girdhar. Assessment of Ischemic Stroke Subtypes Using MR Angiography in North Indian Population. Int J Med Res Prof. 2026 Jan; 12(1): 6-10. DOI:10.21276/ijmrp.2026.12.1.002