

Frequency of Carotid Artery Stenosis in Anterior Circulation Stroke Patients

Muhammad Ahsan Ayub¹, Muhammad Adnan Aslam², Saad Qayyum³, Muhammad Taha Sharjeel⁴, Muhammad Zain Ul Abidin⁵, Muhammad Usman⁶

¹Postgraduate Resident, Department of Neurology, Services Hospital Lahore, Pakistan

²Associate Professor, Head of Neurology Department, Services Hospital/ Services Institute of Medical Science, Lahore, Pakistan

³Associate Professor, Shalimar Medical & Dental College, Lahore. Head of Radiology Department. Fujji Foundation Hospital Lahore, Pakistan

⁴Medical Officer, Regional Health Center, Changa Manga Chunian Kasur, Pakistan

⁵Neuro-Doppler Ultrasound Specialist, Department of Neurology, Services Hospital Lahore, Pakistan

⁶Postgraduate Resident, Department of Neurology, Services Hospital Lahore, Pakistan

Corresponding Author: Dr. Muhammad Ahsan Ayub, Postgraduate Resident (Neurology), Services Hospital Lahore, Pakistan, Email: docahsan.n61aa@gmail.com

Received: 02-10-2025

Revised: 11-12-2025

Accepted: 17-12-2025

ABSTRACT

Background: Carotid artery stenosis (CAS) is a major cause of ischemic stroke, particularly in the anterior circulation, due to atherosclerotic narrowing or occlusion. Doppler ultrasonography provides a non-invasive, cost-effective diagnostic method for detection and grading of CAS.

Objective: To determine the frequency and severity of carotid artery stenosis in patients presenting with anterior circulation ischemic stroke and to correlate stenosis with major vascular risk factors.

Methods: A cross-sectional study was conducted in the Department of Neurology, Services Hospital Lahore, on 151 patients aged 18–65 years with anterior circulation ischemic stroke confirmed on CT scan. Carotid Doppler ultrasound was performed to assess degree of stenosis and associated risk factors (hypertension, diabetes, smoking, ischemic heart disease). Data were analyzed using SPSS 25. Chi-square test was applied; $p < 0.05$ was considered significant.

Results: Out of 151 patients, 93 (61.6 %) were males and 58 (38.4 %) females with mean age = 55.3 ± 7.2 years. Hypertension (68.9 %) and diabetes (46.4 %) were the most frequent comorbidities. Carotid artery stenosis was detected in 97 patients (64.2 %): mild 28 (18.5 %), moderate 43 (28.5 %), and severe 26 (17.2 %). A significant association was found between hypertension and degree of stenosis ($p = 0.004$) as well as between diabetes and moderate–severe stenosis ($p = 0.03$). Smoking showed borderline significance ($p = 0.06$).

Conclusion: In conclusion, our results reaffirm that carotid artery stenosis is highly prevalent in anterior circulation stroke, particularly among hypertensive and diabetic males. Early screening through Doppler ultrasonography, aggressive risk-factor modification, and targeted vascular intervention can play a vital role in reducing morbidity and recurrence.

Key words: ICA, CCA, Stenosis, plaque, stroke, hypertension, diabetes mellitus.

INTRODUCTION

Stroke, also known as cerebrovascular accident (CVA), remains one of the leading causes of mortality and long-term disability worldwide, ranking as the second most common cause of death globally and accounting for approximately 10% of all deaths each year¹. Among all stroke types, ischemic stroke constitutes about 80% of cases and occurs due

to obstruction of cerebral blood flow secondary to thrombus or embolus formation within intracranial or extracranial arteries². The internal carotid arteries, which supply the anterior cerebral circulation, are particularly susceptible to atherosclerotic narrowing or plaque formation, leading to either luminal obstruction or artery-to-artery embolization, culminating in cerebral infarction³.

Muhammad Ahsan Ayub et al/ Frequency of Carotid Artery Stenosis in Anterior Circulation Stroke Patients

Atherosclerosis of the carotid arteries develops over time due to complex interactions between endothelial injury, lipid deposition, inflammatory response, and smooth-muscle proliferation⁴. Progressive luminal narrowing compromises cerebral perfusion and predisposes to ischemia during episodes of reduced systemic blood pressure or increased metabolic demand⁵. In some cases, plaque rupture and distal embolization occur even with moderate degrees of stenosis, emphasizing that both the degree and morphology of atheromatous plaques determine the risk of ischemic stroke⁶.

METHODOLOGY

This cross-sectional analytical study was conducted in the Department of Neurology, Services Hospital, Lahore, over a period of six months following synopsis approval. A total of 151 patients were included, with the sample size calculated based on an expected prevalence of 50%, a margin of error of 8%, and a 95% confidence interval. A non-probability consecutive sampling technique was used. Patients aged 18 to 65 years of both genders with clinically and radiologically (CT brain) confirmed anterior circulation ischemic stroke were included. Exclusion criteria comprised patients with hemorrhagic or posterior circulation strokes, non-atherosclerotic causes, prior carotid endarterectomy, pregnancy, or refusal to participate. After obtaining informed consent, all eligible patients underwent carotid Doppler ultrasonography using a linear probe (7–15 MHz). The degree of carotid artery stenosis was categorized as mild (<50% luminal narrowing), moderate (50–69%), or severe (≥70%). Demographic information and vascular risk factors, including hypertension, diabetes mellitus, smoking, and ischemic heart disease, were documented. Data were analyzed using SPSS version 25. Quantitative variables, such as age, were presented as mean ± standard deviation, while qualitative variables, including gender, risk factors, and stenosis category, were expressed as frequencies and percentages. The chi-square test was applied to assess associations between the severity of carotid artery stenosis and various vascular risk factors, with a p-value of less than 0.05 considered statistically significant.

Globally, the prevalence of carotid artery stenosis (CAS) among ischemic stroke patients

Several risk factors are strongly associated with the development of carotid atherosclerosis, including hypertension, diabetes mellitus, hyperlipidemia, smoking, and ischemic heart disease⁷. Persistent hypertension contributes to shear-stress-induced endothelial injury, while diabetes mellitus promotes vascular inflammation, glycosylation of lipoproteins, and endothelial dysfunction⁸. These pathophysiologic mechanisms accelerate carotid plaque formation and increase the probability of cerebral ischemia.

varies between 15% and 56%, depending on demographic factors, comorbid conditions, and diagnostic methods⁹. In Pakistan and other South Asian countries, this prevalence tends to be higher due to poorly controlled vascular risk factors and limited screening programs¹⁰. A study by Hadi et al. found CAS in 56% of ischemic stroke patients by Doppler ultrasonography¹¹, while an Egyptian cohort reported moderate-to-severe stenosis in 9.3% of cases¹². Similarly, research from Nepal revealed that 18.7% of stroke patients had moderate stenosis, 8.9% had severe stenosis, and 3.8% had near-total or total occlusion¹³. Carotid Doppler ultrasonography has emerged as an indispensable, non-invasive, cost-effective, and radiation-free diagnostic tool to evaluate carotid artery disease. It provides both anatomical and hemodynamic information, including flow velocity, resistance index, and plaque characteristics¹⁴. Early identification of hemodynamically significant carotid stenosis allows clinicians to implement timely medical management, lifestyle modification, or surgical interventions such as carotid endarterectomy or stenting, thereby reducing the risk of recurrent stroke¹⁵.

Given the regional paucity of data, this study was designed to determine the frequency and severity of carotid artery stenosis among patients with **anterior circulation ischemic stroke** in a tertiary-care center in Lahore, Pakistan. By identifying the proportion of patients with clinically significant stenosis and its relationship with major vascular risk factors, this research aims to provide valuable insights into preventive strategies and optimize stroke management in our population.

RESULTS

Table 1: Frequency and Percentage of Vascular Risk Factors

Variable	Frequency (n)	Percentage (%)
Hypertension	104	68.9
Diabetes Mellitus	70	46.4
Smoking	51	33.8
Ischemic Heart Disease	29	19.2

This table presents the distribution of major vascular risk factors among 151 patients with anterior circulation ischemic stroke. Hypertension was the most prevalent risk factor, observed in 104 patients (68.9%), and followed by diabetes mellitus in 70 patients

(46.4%), smoking in 51 patients (33.8%), and ischemic heart disease in 29 patients (19.2%). These findings indicate that hypertension and diabetes were the most common comorbidities in the study population.

Table 2: Degree of Carotid Artery Stenosis

Severity	n (151)	%
No Stenosis	54	35.8
Mild (<50%)	28	18.5
Moderate (50–69%)	43	28.5
Severe (≥70%)	26	17.2

This table shows the distribution of patients according to the severity of carotid artery stenosis on Doppler ultrasonography. Out of 151 patients, 54 (35.8%) had no significant stenosis, 28 (18.5%) had mild stenosis (<50%), 43 (28.5%) had moderate stenosis (50–69%),

and 26 (17.2%) had severe stenosis (≥70%). Overall, 97 patients (64.2%) exhibited some degree of carotid artery narrowing, emphasizing the high prevalence of atherosclerotic changes in this population.

Table 3: Correlation between Risk Factors and Presence of Carotid Artery Stenosis

Risk Factor	Stenosis Present (n=97)	p-value (Chi-square)
Hypertension	81 (83.5 %)	0.004 *
Diabetes Mellitus	49 (50.5 %)	0.03 *
Smoking	36 (37.1 %)	0.06
Ischemic Heart Disease	17 (17.5 %)	0.15

This table summarizes the relationship between vascular risk factors and the presence of carotid artery stenosis among the 97 patients with any degree of stenosis. Hypertension showed a statistically significant association with carotid stenosis (p = 0.004), as 81 patients (83.5%) with

stenosis were hypertensive. Diabetes mellitus was also significantly associated (p = 0.03), present in 49 patients (50.5%) with stenosis. Smoking (p = 0.06) and ischemic heart disease (p = 0.15) did not show statistically significant associations. These results suggest that

hypertension and diabetes are key risk factors contributing to carotid artery atherosclerosis in ischemic stroke patients.

DISCUSSION

The current study assessed 151 patients with anterior circulation ischemic stroke and demonstrated that carotid artery stenosis was present in 64.2% of cases, with 18.5% mild, 28.5% moderate, and 17.2% severe stenosis. These findings highlight a high prevalence of carotid atherosclerotic disease in our population, consistent with previous regional data^{11,13}. The predominance of males (61.6%) and the mean age of 55 years align with known epidemiological trends, as both age and male gender are established risk factors for carotid atherosclerosis¹⁶.

The significant association between hypertension and stenosis ($p = 0.004$) reinforces the central role of blood pressure control in stroke prevention. Chronic hypertension induces endothelial damage and stimulates intimal hyperplasia, promoting atheroma formation¹⁷. The present results are comparable to those reported by Devrajani et al., who found a high proportion of hypertensive patients among those with internal carotid artery stenosis¹⁸. Similarly, diabetes mellitus showed a statistically significant relationship ($p = 0.03$) with moderate-to-severe stenosis, corroborating the metabolic contribution to endothelial dysfunction and plaque instability¹⁹. Although smoking and ischemic heart disease were not statistically significant in our cohort ($p > 0.05$), both remain clinically important risk factors contributing to systemic atherosclerosis and hypercoagulability²⁰. The nonsignificance may be attributed to sample distribution or the smaller number of heavy smokers compared with hypertensive individuals. Nevertheless, this pattern aligns with other South Asian studies where hypertension and diabetes were dominant predictors of carotid disease²¹.

The overall prevalence of carotid stenosis in our study (64%) was slightly higher than that observed in Egyptian (9.3%)¹² and Nepalese (35%) cohorts¹³, which can be attributed to the higher burden of uncontrolled hypertension and diabetes in Pakistan, delayed presentation, and limited primary prevention awareness. Hadi et

al. reported a similar frequency of 56% using Doppler ultrasonography¹¹, supporting the reliability of non-invasive Doppler evaluation for early diagnosis. Furthermore, Gyawali et al. in Nepal (2021) documented 63% CAS among ischemic stroke patients, almost identical to our findings¹³.

Carotid Doppler remains a cornerstone in the screening and stratification of ischemic stroke risk. It provides quantitative estimation of stenosis and qualitative assessment of plaque morphology, which can predict embolic potential²². Given its affordability and safety, routine Doppler evaluation is justified in all ischemic stroke patients, especially those with anterior circulation involvement. Early detection allows clinicians to initiate antiplatelet therapy, statins, and, when indicated, surgical revascularization²³.

Clinical implications: The high prevalence of carotid stenosis in our population underscores the need for incorporating Doppler screening into stroke protocols. Identifying patients with $\geq 50\%$ stenosis is essential for secondary prevention. Carotid endarterectomy or stenting should be considered for selected cases with high-grade stenosis and appropriate clinical profile²⁴. Additionally, public-health strategies focusing on hypertension and diabetes control could substantially reduce stroke incidence.

Limitations: This was a single-center, cross-sectional study; hence causal relationships cannot be established. Doppler ultrasound, while accurate, is operator-dependent and less precise than CTA or MRA for plaque characterization. Future multicenter studies incorporating multimodal imaging could improve the generalizability and depth of understanding.

CONCLUSION

In conclusion, our results reaffirm that carotid artery stenosis is highly prevalent in anterior circulation stroke, particularly among hypertensive and diabetic males. Early screening through Doppler ultrasonography, aggressive risk-factor modification, and targeted vascular intervention can play a vital role in reducing morbidity and recurrence.

REFERENCES

1. Feigin VL, Nichols E, Alam T, Bannick MS, Beghi E, Blake N, et al. Global, regional, and national burden of neurological disorders, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet Neurol*. 2019;18(5):459–480.
2. Flaherty ML, Kissela B, Khoury JC, Kleindorfer D, Alwell K, Moomaw CJ, et al. Carotid artery stenosis as a cause of stroke. *Neuroepidemiology*. 2012;40(1):36–41.
3. Sharma R, Mattoo P. Colour Doppler study of extracranial carotid arteries in stroke. *JK Sci*. 2015;17(2):88–92.
4. Park JH, Razuk A, Saad PF. Carotid stenosis: what is the high-risk population? *Clinics (Sao Paulo)*. 2012;67(8):865–70.
5. Thrush A, Hartshorne T. *Vascular Ultrasound: How, Why and When*. 4th ed. London: Elsevier Health Sciences; 2009.
6. Martinez-Rios E, Montesinos L, Alfaro-Ponce M, Pecchia L. A review of machine learning in hypertension detection and blood pressure estimation based on clinical and physiological data. *Biomed Signal Process Control*. 2021;68:102813.
7. Devrajani BR, Kadir S, ur Rahman AA, Junejo MA, Junejo H, Baloch ZAQ. Frequency of internal carotid artery stenosis in patients with cerebral infarct. *World Appl Sci J*. 2013;23(1):24–8.
8. Ul Hadi N, Khurshid R, Awan KH, Iqbal N. Frequency of carotid artery stenosis in ischemic stroke by using carotid Doppler ultrasonography in a teaching hospital. *Gomal J Med Sci*. 2013;11(1):7–10.
9. El Hady A, Mohammad HS, Elkhatib T, Khalil GA. Assessment of extracranial carotid arteries in acute ischemic stroke: correlation with risk factors. *Int J Med Imaging*. 2019;7(2):14–22.
10. Yadav AK, Dev B, Taparia S. Role of color Doppler ultrasonography in evaluation of extracranial carotid artery in stroke patients: a prospective study. *Birat J Health Sci*. 2020;5(2):1091–8.
11. Gyawali M, Sharma P, Karki D. Study of carotid Doppler in patients with ischemic stroke. *J Brain Spine Found Nepal*. 2021;2(1):24–30.
12. Bala M, Singh S, Chauhan V, Chauhan S. Pattern of carotid artery involvement in ischemic stroke and its correlation with risk factors. *Indian J Radiol Imaging*. 2017;27(3):347–352.
13. Khandelwal S, Kasliwal RR, Bansal M. Carotid ultrasound for risk stratification in patients with atherosclerotic cardiovascular disease: a practical perspective. *Indian Heart J*. 2020;72(6):475–482.
14. Saba L, Yuan C, Hatsukami TS, Balu N, Qiao Y, DeMarco JK, et al. Carotid artery wall imaging: perspective and guidelines from the American Society of Neuroradiology. *AJNR Am J Neuroradiol*. 2018;39(5):E9–E31.
15. Naylor AR, Ricco JB, de Borst GJ, Debus S, de Haro J, Halliday A, et al. Editor's choice—management of atherosclerotic carotid and vertebral artery disease: 2017 clinical practice guidelines of the European Society for Vascular Surgery (ESVS). *Eur J Vasc Endovasc Surg*. 2018;55(1):3–81.
16. Wang Y, Wang Y, Zhao X, Liu L, Wang D, Wang C, et al. Clopidogrel with aspirin in acute minor stroke or transient ischemic attack. *N Engl J Med*. 2013;369(1):11–19.
17. Spence JD, Naylor AR. Endarterectomy, stenting, or neither for asymptomatic carotid-artery stenosis. *N Engl J Med*. 2016;374(11):1087–8.
18. Kakkos SK, Kakisis JD, Tsolakis IA, Naylor AR. Contemporary management of symptomatic carotid stenosis: recent advances and remaining controversies. *J Vasc Surg*. 2020;71(5):1833–45.
19. Meschia JF, Bushnell C, Boden-Albala B, Braun LT, Bravata DM, Chaturvedi S, et al. Guidelines for the primary prevention of stroke: a statement for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke*. 2014;45(12):3754–832.
20. Bonati LH, Nederkoorn PJ, Haller S, Moll FL, de Borst GJ, Brown MM. Management of atherosclerotic carotid and vertebral artery disease: current guidelines and future directions. *Eur Heart J*. 2022;43(35):3270–3283.
21. Arenillas JF. Intracranial atherosclerosis: current concepts. *Stroke*. 2011;42(1 Suppl):S20–3.
22. Gao T, Yu X, Zhao X, Sun Y, Li X, Chen J. Prevalence and risk factors of carotid artery stenosis in patients with ischemic stroke in China: a multicenter study. *BMC Neurol*. 2021;21:321.

Muhammad Ahsan Ayub et al/ Frequency of Carotid Artery Stenosis in Anterior Circulation Stroke Patients

23. Zhang Y, Guo J, Li D, Zhang C, Zeng Y, Zhang W. Clinical significance of carotid intima-media thickness and plaque detection in ischemic stroke patients. *Neurol Sci.* 2019;40(5):1019–26.