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FREQUENCY OF CAROTID ARTERY STENOSIS IN ISCHEMIC STROKE PATIENTS

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Abstract

Objective: *To determine the frequency of carotid artery stenosis in ischemic stroke patients at a teaching hospital.* ***Study design:*** *It's a cross-sectional study.* ***Settings:*** *Department of Diagnostic Radiology Combined Military Hospital (CMH), Lahore from October 2024 to May 2025.* ***Methodology:*** *A total of 185 ischemic stroke patients aged 18–60 years were recruited using non-probability consecutive sampling. Carotid artery stenosis was assessed via Doppler ultrasound using NASCET criteria. Severity was classified as mild, moderate, severe, or total occlusion.* ***Results:*** *Among 185 ischemic stroke patients, 84.3% had carotid artery stenosis as detected by Doppler ultrasound. Moderate stenosis (50–69%) was most common, followed by mild, severe, and total occlusion. Smoking was significantly associated with CAS ($p = 0.026$). Age, BMI, hypertension, and diabetes showed no statistically significant association.* ***Conclusion:*** *Carotid artery stenosis was highly prevalent among ischemic stroke patients in this study. Routine Doppler screening is crucial for early detection, especially in high-risk individuals. Preventive strategies targeting modifiable risk factors like smoking are essential..*

INTRODUCTION

Stroke ranks as a top cause of death and serious disability, particularly in the elderly worldwide. It is caused by an interruption in blood flow to the brain, often due to arterial blockage, resulting in reduced oxygenation and damage. There are several types, including ischemic stroke, hemorrhagic stroke, and TIA.[1,2] Ischemic stroke is especially concerning due to its high rate of mental and physical impairment and its position as the third leading cause of death in developed nations.[3] The WHO reported 5.7 million stroke-related deaths in 2015, with more than 50% in Asia. The Pakistani population shows a 4.8% stroke prevalence.[4]

Multiple risk factors contribute to stroke, with carotid artery stenosis (CAS) being one of the most prominent, responsible for 20–30% of ischemic strokes. CAS can either be asymptomatic or manifest as a transient ischemic attack or stroke in the

vascular territory supplied by the stenotic artery.[5] The condition becomes increasingly prevalent with age and in individuals with metabolic diseases. Age-related degenerative processes, along with metabolic, endocrine, or autoimmune disorders, can lead to arterial narrowing. Carotid duplex ultrasound is a non-invasive tool commonly used for diagnosing CAS. Though arteriography is the most accurate diagnostic method, it is invasive and costly, with the potential for serious complications.[6] Treatment strategies vary based on the extent of stenosis. Mild cases are managed conservatively with risk factor control and antithrombotics, while moderate to severe stenosis may necessitate procedures like carotid endarterectomy or angioplasty, with surgery being the first-line option for suitable patients.[7]

Several regional and international studies have reported varying frequencies of carotid artery stenosis (CAS) among patients with ischemic stroke. In Pakistan, Hadi et al. (2009) identified CAS in 56% of patients undergoing color Doppler ultrasonography in Peshawar.[8] Fatima et al. (2019) reported a prevalence of 63.5% in Islamabad,[9] while Begum et al. (2022) found 52.9% of ischemic stroke patients had CAS in Karachi.[10] Another Karachi-based study by Kumar et al. (2019) observed a lower frequency of significant CAS at 27.7%.[11] Internationally, Bharathi et al. (2019) reported a 46% prevalence of CAS among stroke patients in India.[12] Van et al. (2021) recorded 18.7% prevalence in the Netherlands,[13] whereas Mettananda et al. (2021) noted a substantially lower rate of 4.0% in Sri Lanka.[14] In the Philippines, Diamante et al. (2019) found that only 5% of acute ischemic stroke patients had significant CAS.[15] The highest prevalence was reported by Sultana et al. (2014), with 86% of stroke patients in Bangladesh diagnosed with CAS.[16]

Existing literature presents considerable variability in the reported frequency of carotid artery stenosis (CAS) among ischemic stroke patients, both internationally and within Pakistan. Prevalence rates range from 4.0% in Sri Lanka[14] to 86% in Bangladesh[16], while Pakistani studies report figures from 27.7%[11] to 63.5%[9]. Given these inconsistencies, the current study aims to re-evaluate the frequency of CAS in our local context. The results will help better define the extent of the problem and aid in the early identification of patients at risk.

METHODOLOGY:

This cross-sectional study was conducted at the Department of Diagnostic Radiology, Combined Military Hospital (CMH), Lahore from October 2024 to May 2025. A total of 185 patients were recruited through non-probability consecutive sampling. The sample size was calculated using a 95% confidence level, a 5% margin of error, and an expected frequency of carotid artery stenosis of 86% in ischemic stroke patients. Patients of both genders, aged between 18 and 60 years, with a history of ischemic stroke within the past two weeks and meeting the operational definition criteria, were included. Informed written consent was obtained from each participant. Exclusion criteria included patients with hemorrhagic stroke, space-occupying lesions on CT, head trauma, cardiac-origin strokes, chronic alcohol use, meningeal irritation signs, posterior circulation infarction, or those on anticoagulants or corticosteroids before the stroke episode. Patients with comorbidities such as diabetes mellitus, chronic liver disease, or renal dysfunction were also excluded to minimize confounding.

Each patient underwent a detailed clinical history and physical examination. Body mass index (BMI) was calculated based on measured weight and height using the standard formula. Carotid Doppler ultrasound was performed using a Siemens Acuson Antares system with a 10 MHz linear transducer. The scans were conducted with the patient in a supine position with neck extended to the left. Carotid artery stenosis was diagnosed according to the NASCET criteria, and the severity was classified as mild (<50%), moderate (50–69%), severe (70–99%), or total occlusion (100%). All ultrasound results were cross-verified by a consultant radiologist with a minimum of five years of clinical experience to ensure diagnostic accuracy.

Patient data including demographics, clinical variables such as hypertension, diabetes status, smoking history, and presence and severity of carotid artery stenosis were recorded on a predesigned proforma. To eliminate inter-laboratory variation, all relevant laboratory investigations were conducted in the same institutional laboratory. Numerical

variables like age, BMI, and duration of illness were expressed as mean ± standard deviation. Categorical variables including gender, presence of hypertension, diabetes, smoking status, and severity of carotid artery stenosis were summarized using frequencies and percentages. Stratification was performed based on age, gender, duration of illness, hypertension, diabetes, dyslipidemia, and smoking status to assess the impact of potential effect modifiers. Chi-square tests were applied post-stratification, and a p-value ≤0.05 was considered statistically significant.

RESULTS:

Table 1 presents the demographic and clinical characteristics of the 185 patients included in the study. Among the participants, 40.0% were aged 50 years or younger, while the majority, 60.0%, were older than 50 years. Males comprised 57.3% of the study population, and females 42.7%. The vast majority of patients (91.4%) had a body mass index (BMI) of 30 kg/m² or less, while only 8.6% had a BMI greater than 30. Regarding comorbidities, 61.1% of patients were hypertensive and 34.6% were diabetic. All patients had ischemic stroke, and therefore, the presence of diabetes was noted as a coexisting condition. Smoking was prevalent in 46.5% of the patients, while 53.5% were non-smokers. The average age of the patients was 51.65 ± 5.23 years, the mean BMI was 26.57 ± 2.51 kg/m², and the average duration of disease was 1.48 ± 0.50 weeks.

Table 2 illustrates the frequency of carotid artery stenosis (CAS) among the ischemic stroke patients. Out of the total 185 cases, 156 patients (84.3%) were diagnosed with CAS based on Doppler ultrasound criteria, while only 29 patients (15.7%) did not have stenosis. These findings underscore the high prevalence of CAS in patients presenting with ischemic stroke in this cohort, reinforcing the significance of carotid assessment in such individuals.

Table 3 provides a stratified comparison of demographic and clinical variables with the presence or absence of carotid artery stenosis. Among patients with CAS, 42.9% were aged ≤50 years and 57.1% were >50 years, compared to 24.1% and 75.9%, respectively, in those without CAS, suggesting a trend toward higher stenosis prevalence in older individuals, although the p-value of 0.058 narrowly missed statistical significance. BMI categories did not significantly differ between the groups (p = 0.283), with the majority of both groups having a BMI ≤30. Hypertension was slightly more common in the CAS group (60.3%) compared to the non-CAS group (65.5%), but the association was not statistically significant (p = 0.594). A higher proportion of diabetic patients was found in the non-CAS group (48.3%) compared to the CAS group (32.1%), with a p-value of 0.092, indicating a non-significant trend. Smoking status, however, showed a statistically significant association with CAS (p = 0.026), where 50.0% of patients in the CAS group were smokers compared to only 27.6% in the non-CAS group.

Table 4 delineates the distribution of CAS severity among patients. Of the 156 patients diagnosed with CAS, 28.2% had mild stenosis, 41.7% had moderate stenosis, 21.8% had severe stenosis, and 8.3% had total occlusion. In contrast, all patients without CAS (100.0%) had no stenosis. The most common severity category was moderate stenosis. The difference in distribution across severity categories was highly significant (p < 0.001), demonstrating a clear distinction in vascular findings between patients with and without CAS. These findings emphasize the clinical importance of assessing not just the presence of stenosis but its severity as well, as it may influence both prognosis and management strategies.

Table 1: Demographic Details of Patients (n = 185)

Variable	Group	Count	Percent
Age (years)	≤50 years	74	40.0%
	>50 years	111	60.0%
Gender	Male	106	57.3%
	Female	79	42.7%
BMI (kg/m²)	≤30	169	91.4%

	>30	16	8.6%
Hypertension	Yes	113	61.1%
	No	72	38.9%
Diabetes Mellitus	Yes	64	34.6%
	No	185	100.0%
Smoking Status	Smoker	86	46.5%
	Non-Smoker	99	53.5%
Mean Age (years)		Mean ± SD	51.65 ± 5.23
Mean BMI (kg/m²)			26.57 ± 2.51
Mean Duration of Disease (weeks)			1.48 ± 0.50

Table 2: Frequency of Carotid Artery Stenosis in Ischemic Stroke Patients (n = 185)

CAS	Frequency	Percent
Yes	156	84.3
No	29	15.7
Total	**185**	**100.0**

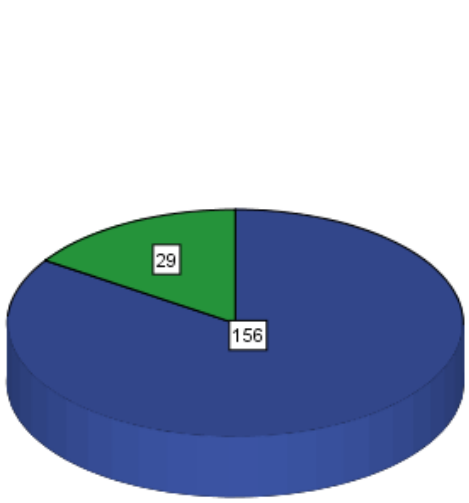

Fig. 1

Table 3: Stratified Comparison of Demographic and Clinical Variables with CAS (n = 185)

Variable		CAS = Yes (n=156)	CAS = No (n=29)	p-value[a]
Age (years)	≤50	67 (42.9%)	7 (24.1%)	0.058
	>50	89 (57.1%)	22 (75.9%)	
BMI	≤30	144 (92.3%)	25 (86.2%)	0.283
	>30	12 (7.7%)	4 (13.8%)	
Hypertension	Yes	94 (60.3%)	19 (65.5%)	0.594
	No	62 (39.7%)	10 (34.5%)	
Diabetes Mellitus	Yes	50 (32.1%)	14 (48.3%)	0.092
	No	106 (67.9%)	15 (51.7%)	
Smoking	Smoker	78 (50.0%)	8 (27.6%)	0.026
	Non-Smoker	78 (50.0%)	21 (72.4%)	

[a]chi square test

Table 4: Distribution of CAS Severity Among Patients (n = 185)

CAS Severity	CAS = Yes (n=156)	CAS = No (n=29)	Total (n=185)	p-value[a]
Mild	44 (28.2%)	0 (0.0%)	44 (23.8%)	0.000
Moderate	65 (41.7%)	0 (0.0%)	65 (35.1%)	
Severe	34 (21.8%)	0 (0.0%)	34 (18.4%)	
No Stenosis	0 (0.0%)	29 (100.0%)	29 (15.7%)	
Total Occlusion	13 (8.3%)	0 (0.0%)	13 (7.0%)	

[a]chi square test

DISCUSSION:

Stroke remains a leading cause of disability and death worldwide, particularly in the elderly, and ischemic stroke constitutes the majority of cases. Carotid artery stenosis (CAS), which results from atherosclerotic plaque formation in the extracranial carotid arteries, is a significant etiological factor, implicated in approximately 20–30% of ischemic strokes. The global prevalence of CAS among ischemic stroke patients varies considerably across populations, likely due to genetic, environmental, and healthcare disparities.

In our study, the mean age of ischemic stroke patients was 51.65 ± 5.23 years, with the majority (60.0%) aged >50 years. This age profile aligns closely with findings by Begum et al,[10] who reported a mean age of 53.14 ± 7.49 years among 170 ischemic stroke patients in Karachi, further substantiating the increased risk of CAS with advancing age. In contrast, the Sri Lankan study by Mettananda et al[17] involved a broader cohort of 550 patients but found only 4.0% prevalence of CAS, indicating regional variability and possibly earlier stroke onset due to other mechanisms in that population. Regarding gender distribution, our study included 57.3% males and 42.7% females, which mirrors patterns reported by Ali et al,[18] who also found a male predominance in their sample. Similarly, Das et al[19] observed that men were more frequently affected in northeast India, reinforcing the concept that male gender may confer greater susceptibility to extracranial atherosclerosis in ischemic stroke.

Our data showed that 91.4% of patients had a BMI ≤30 kg/m², suggesting that while obesity is a known vascular risk factor, it may not be a dominant variable in this cohort. Few regional studies included BMI stratification; however, Khedr et al[20] from Egypt reported high levels of hyperlipidemia (70.6%), a surrogate marker for metabolic syndrome, among ischemic stroke patients with CAS, suggesting possible differences in lipid profiles despite similar BMI patterns.

Hypertension was present in 61.1% of our patients, similar to the Egyptian study (74.8%) by Khedr et al,[20] the Indian cohort by Das et al[19] (71.33%), and the Sri Lankan study by Mettananda et al.[17] (a statistically significant correlate of CAS). This supports the notion that hypertension remains a critical modifiable risk factor across diverse populations.

Diabetes mellitus was found in 34.6% of our cohort. While this is lower than the prevalence reported by Das et al[19] (56.05%) and Khadim et al[21] (46%), it still represents a substantial comorbid condition that may compound vascular damage and stroke risk. Smoking history, reported in 46.5% of our patients, showed a statistically significant association with CAS ($p = 0.026$). This observation is corroborated by Khadim et al,[21] who noted 58% of stroke patients with CAS were smokers, and Begum et al,[10] who found smoking significantly associated with CAS ($p < 0.05$). This reinforces the role of tobacco as a potent risk factor in vascular pathology.

Our finding of 84.3% prevalence of CAS in ischemic stroke patients is one of the highest reported in regional literature. It is consistent with Ali et al,[18] who reported 84% prevalence using similar Doppler ultrasound methods in a comparable Pakistani population. However, this figure stands in contrast to lower rates such as 52.9% reported by Begum et al[10] and 27.7% by Kumar et al,[11] as cited in the introduction. Internationally, Sri Lanka reported a

mere 4.0% prevalence,[14] while Bangladesh showed an extremely high figure of 86%, indicating wide variability, possibly due to differences in study populations, diagnostic protocols, and inclusion criteria.

The observed frequency of CAS in our study (84.3%) is considerably high and consistent with the findings of Ali et al,[18] who also reported 84% prevalence among ischemic stroke patients using Doppler ultrasound in a similar clinical setting. This substantial burden contrasts with several regional and international studies. For instance, Khadim et al[21] found CAS in 59% of patients with recurrent ischemic stroke, while Begum et al[10] observed a prevalence of 52.9% in Karachi. On the lower end, Das et al.[19] from India reported stenosis ≥50% in 23.6% of first-time ischemic stroke patients, and Mettananda et al[17] reported just 4.0% in a large Sri Lankan cohort. These discrepancies likely reflect variations in study design, diagnostic modalities, patient selection criteria, and population-level cardiovascular risk profiles. Our higher prevalence may also reflect earlier or more aggressive atherosclerotic changes in the local population, underscoring the urgent need for preventive strategies.

The high prevalence of carotid artery stenosis (84.3%) observed in this study is consistent with findings by Kumar et al[11] who reported significant stenosis in 86% of Bangladeshi stroke patients. Similarly, Handique et al[22] emphasized the burden of extracranial CAS in first-ever stroke cases. Conversely, Van et al. in the Netherlands documented a much lower prevalence (18.7%), reflecting geographic and population-level variations. Similar to findings by Akl et al[23] who linked severe CAS with poor stroke outcomes, Other stdies[24-25] also noted a high frequency (68%) of carotid atherosclerosis in cerebral infarction cases. In contrast, Diamante et al[15] reported only 5% prevalence in Filipino stroke patients, highlighting stark interregional differences. However, severity grading plays a crucial role in clinical decision-making, as patients with high-grade stenosis are at markedly increased risk of recurrent stroke and may benefit from timely revascularization procedures.

Taken together, our results underscore the high burden of carotid artery stenosis in ischemic stroke patients in Pakistan and confirm the importance of routine carotid Doppler screening, especially in individuals with known risk factors like hypertension, smoking, and age >50 years. The variation in CAS frequency across studies highlights the need for standardized diagnostic protocols and multicenter national registries to harmonize surveillance and intervention strategies.

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