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# Incidence of carotid artery stenosis in acute ischemic stroke at BMC Hospital Quetta

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## ABSTRACT

**Background and objectives.** This study aimed to explore the prevalence, severity, and distribution of carotid artery stenosis among patients experiencing ischemic strokes.

**Materials and methods.** This prospective hospital-based cross-sectional study was conducted at Bolan Medical Complex Hospital in Quetta, Baluchistan, Pakistan. The research spanned one year, from April 2022 to April 2023, involving 153 patients.

**Results.** The study revealed that individuals in their 50s to 70s were predominantly affected, with the most common CT findings being the right middle cerebral artery (MCA), left MCA, and right posterior cerebral artery (PCA). Among the participants, 19.0% exhibited carotid artery stenosis, with a male predominance. The distribution of stenosis severity included 8.5% with mild, 5.9% with moderate, 3.9% with severe, and 0.7% with total occlusion. The affected anatomical sites were the carotid bulb, common carotid artery, common carotid artery bifurcation, internal carotid artery, and external carotid artery in 7.8%, 5.2%, 2.0%, 2.6%, and 1.3% of patients, respectively. Right-sided stenosis was observed in 9.8% of cases, surpassing left-sided stenosis at 7.2%. Logistic regression analysis did not identify age and gender as significant predictors of stenosis.

**Conclusions.** This study underscores the critical significance of early detection and intervention for carotid artery stenosis in high-risk acute ischemic stroke patients, aiming at stroke prevention.

**Keywords:** stenosis, Doppler ultrasound, atherosclerosis, computed tomography scan

## Abbreviations (in alphabetical order):

| | | | |
|---|---|---|---|
| ACA | – anterior cerebral artery | NASCET | – North American Symptomatic Carotid Endarterectomy Trial |
| AICA | – anterior inferior cerebellar artery | OR | – odds ratio |
| BMC | – Bolan Medical Complex | PCA | – posteriorcerebral artery |
| CAS | – carotid artery stenosis | PICA | – posterior inferior cerebellar artery |
| CCA | – common carotid artery | SPSS | – statistical package for the social sciences |
| CT | – computed tomography | SD | – standard deviation |
| ECST | – European Carotid Surgery Trialists | | |
| ICA | – internal carotid artery | | |
| MCA | – middle cerebral artery | | |

## INTRODUCTION

Ischemic stroke stands as the leading global cause of death and disability [1]. Strokes are usually categorized into ischemic (85%) and hemorrhagic (15%) based on their underlying causes [2]. Among ischemic strokes, about 80% are thromboembolic strokes, often

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originating from plaques in the carotid artery [3]. The narrowing or obstruction of carotid arteries, known as carotid artery stenosis (CAS), significantly contributes to ischemic strokes [4]. Despite advancements, a considerable number of stroke cases remain of unknown etiology, even after considering heart and carotid diseases [5].

CAS is a condition where the carotid arteries that supply blood to the brain becomes narrow or blocked, thus posing a significant threat of ischemic stroke [6]. CAS can be found in almost 20% of all stroke cases [7]. Early diagnosis and treatment of CAS are crucial for reducing risk of recurrent strokes and improving outcomes in patients with acute ischemic stroke [8]. However, its ability to diagnose acute ischemic stroke remains uncertain despite being cost-effective and widely available diagnostic tools for evaluating CAS like carotid Doppler ultrasound [9]. Therefore, understanding the prevalence of CAS in acute ischemic stroke patients is essential to make informed clinical decisions and achieve better patient outcomes.

Due to its impact on treatment options, accurate diagnosis of CAS is essential. If symptomatic CAS exceeds 70%, patients may need carotid endarterectomy which involves removing plaque from the carotid artery through surgical operation [10]. Less severe stenosis may require medical management using antiplatelet or anticoagulant drugs. In order to determine the most appropriate course of treatment, an accurate diagnosis of CAS must be made by healthcare practitioners before implementation of any therapeutic interventions [11].

This study draws on research such as the European carotid surgery trialists (ECST) and the North American Symptomatic Carotid Endarterectomy Trial (NASCET) [12], highlighting the significant benefits of carotid endarterectomy in optimizing outcomes for patients with internal carotid lumen diameter narrowing of 70% or more and recent stroke symptoms.

Understanding the frequency of CAS in acute ischemic stroke patients is critical for informing clinical decisions and improving patient outcomes. Despite variations in prevalence across studies, it is evident that CAS is a prevalent comorbidity in acute ischemic stroke patients, particularly in those with anterior circulation stroke and older age male patients. Accurate CAS diagnosis is essential for providing appropriate treatment options. Further research is warranted to comprehend risk factors for CAS better and enhance diagnostic and treatment strategies for this condition.

## MATERIALS AND METHODS

### Study design

A hospital-based prospective cross-sectional study was conducted to investigate the incidence of carotid artery stenosis in patients with acute ischemic stroke.

### Setting

The study was conducted at the Bolan Medical Complex in Quetta, the provincial capital of Balochistan in Pakistan.

### Participants

The study population consisted of patients with symptoms suggestive of acute ischemic stroke during the defined period. Stroke cases were ascertained using computed tomography scan and was exclusive of hemorrhagic stroke. A total of 153 patients were enrolled within one year from April 2022 to April 2023.

### Data collection

Following the acquisition of informed consent from each patient, a thorough physical examination and comprehensive medical history were conducted. Carotid Doppler ultrasound was performed on all patients to determine the degree of carotid artery stenosis. The assessment of stenosis severity utilized the North American Symptomatic Carotid Endarterectomy Trial (NASCET) criteria [13,14]. Significant stenosis was defined as a patient having stenosis greater than 50%.

### Data analysis

Data were analyzed using the SPSS software version 25.0. Categorical variables were presented as frequencies and percentages. Meanwhile, continuous variables were summarized using mean values accompanied by standard deviations. In the assessment of predictors for Stenosis, logistic regression analysis was employed. The significance of predictors was evaluated based on odds ratios, 95% confidence intervals, and p-value < 0.05.

### Ethical considerations

The institutional ethical review board of Bolan Medical Complex Hospital Quetta, Balochistan [Reference # PGMI/ERC/1/2024], approved the study. Informed consent was obtained from all patients before inclusion in the trial, and patient privacy was rigorously maintained throughout the study.

## RESULTS

Table 1 presents the demographic characteristics of the study participants, offering a snapshot of the sample composition. The gender distribution shows that 63.4% of the participants were male (97 individuals), while 36.6% were female (56 individuals). The mean ± standard deviation represents the age profile,

**TABLE 1.** Demographic characteristics of study participants

| Variables | | N (%) |
|---|---|---|
| Gender | Male | 97(63.4) |
| | Female | 56(36.6) |
| Age (years); Mean±SD | | 61.16±14.22 |

**TABLE 2.** CT findings and stenosis characteristics

| Variables | | N (%) |
|---|---|---|
| CT findings | Right MCA | 42(27.5) |
| | Right MCA/ACA | 3(2.0) |
| | Right MCA/PCA | 6(3.9) |
| | Left MCA/PCA | 2(1.3) |
| | Right MCA Left PCA | 3(2.0) |
| | Left MCA | 37(24.2) |
| | Right ACA | 6(3.9) |
| | Right AICA | 4(2.6) |
| | Right PCA | 25(16.3) |
| | Right PICA | 13(8.5) |
| | Left PCA | 7(4.6) |
| | Left PICA | 4(2.6) |
| | Left MCA/ACA | 1(.7) |
| Stenosis | No Stenosis | 124 (81.0) |
| | Stenosed | 29 (19.0) |
| Percentage of stenosis | Not detected | 124(81.0) |
| | Mild (<50%) | 13(8.5) |
| | Moderate (50-69%) | 9(5.9) |
| | Severe (70 %) | 6(3.9) |
| | Complete occlusion | 1(.7) |
| Plaque localization | None | 124(81.0) |
| | Carotid Bulb | 12(7.8) |
| | Common Carotid Artery (CCA) | 8(5.2) |
| | Common Carotid Artery Bifurcation | 3(2.0) |
| | Internal Carotid Artery (ICA) | 4(2.6) |
| | External Carotid Artery (ECA) | 2(1.3) |
| Site of stenosis | None | 124(81.0) |
| | Right | 15(9.8) |
| | Left | 11(7.2) |
| | Bilateral | 3(2.0) |

**TABLE 3.** Logistic regression analysis for stenosis with gender and age

| Variables | | Stenosis N(%) | | OR | 95% CI | p-value |
|---|---|---|---|---|---|---|
| | | No Stenosis | Stenosed | | | |
| | Male | 78(62.9) | 19(65.5) | 1.139 | 0.484-2.683 | 0.766 |
| | Female | 46(37.1) | 10(34.5) | Ref | | |
| Age (years) | | 61.30±13.80 | 60.59±16.17 | .996 | 0.968-1.025 | 0.779 |

**p<0.05 is considered statistically significant*

indicating an average age of 61.16 years with a standard deviation of 14.22.

Table 2 provides a detailed overview of the CT findings and characteristics of carotid artery stenosis among the study participants. Most CT findings were associated with the middle cerebral artery (MCA), with variations such as right MCA, left MCA, and combinations with other arteries. Regarding stenosis, 19.0% of patients exhibited carotid artery stenosis, with varying degrees, including mild (8.5%), moderate (5.9%), severe (3.9%), and complete occlusion (0.7%). Plaque localization revealed diverse affected areas, with the carotid bulb being the most common (7.8%). The site of stenosis indicated a higher prevalence on the right side (9.8%) compared to the left (7.2%), and a few cases exhibited bilateral involvement (2.0%).

Table 3 presents the results of logistic regression analysis examining the association between gender, age, and the occurrence of carotid artery stenosis. The analysis revealed that gender was not a significant predictor of stenosis, as the odds ratio (OR) for males compared to females was 1.139 (95% CI: 0.484-2.683, p = 0.766), indicating no statistically significant difference in the likelihood of stenosis between genders. Additionally, age did not emerge as a significant factor, with an OR of 0.996 (95% CI: 0.968-1.025, p = 0.779), suggesting that the odds of stenosis did not vary significantly with age.

## DISCUSSION

Acute ischemic stroke stands as a leading cause of global morbidity and mortality. Numerous studies have delved into the connection between acute ischemic stroke and carotid artery stenosis. This particular study aims to unravel the frequency, degree, and location of carotid artery stenosis in individuals experiencing acute ischemic strokes. The findings indicate that 19% of the patients showcased carotid artery stenosis, with a higher prevalence in the right carotid artery compared to the left—a trend consistent with prior research. These outcomes contribute valuable insights into the distribution and occurrence of carotid artery stenosis among individuals with ischemic stroke. Existing studies reveal a prevalence range of CAS in ischemic stroke patients spanning from 9.2% to 30.7% [5,15]. These results underscore its significant role in the development of acute ischemic stroke.

The main CT finding in this study was right middle cerebral artery (MCA) followed by the left MCA and right posterior cerebral artery (PCA). It has been previously shown that infarctions within the middle cerebral artery (MCA) ter-

ritory were the most common, followed by PCA territory infarcts [16]. Similarly, another study by Arboix et al. also reported PCA infarctions as the second most frequent after MCA infarctions [17]. Conversely, in our research we have found that there were fewer cases of left MCA/ACA, left posterior inferior cerebellar artery (PICA), and right anterior inferior cerebellar artery (AICA) infarctions than Kovač et al.'s work did in 2006. As per their observation, ACA infarctions were more frequent than PICA and AICA ones while MCA and PCA occurred less frequently because [18] combined territory analysis of the present study showed that only 2% had right MCA/ACA infarctions while 3.9% had right MCA/PCA infraction aligning with Paciaroni et al.'s rate of rarity [19].

The assessment on carotid stenosis in this study was done using the percentage area reduction method. A small number of individuals (8.5%) had mild, moderate and severe forms of the disease while the vast majority (81.0%) had no stenosis at all. These findings support those of Liu et al., implying that a limited number of people suffer from clinically significant carotid artery blockage in large populations [20]. Indeed, a few studies have even suggested higher incidence rates of severe stenosis among patients with ischemic stroke [21, 22]. On account to some extent for evaluating stenosis, unlike previous researches like NASCET and ECST investigations which utilized diameter reduction criteria, this current study stood out as well as differed from other earlier works. In NASCET research; it was defined by significant stenosis as a diameter reduction of 70% or more compared to ECST study where it was given as a diameter reduction of 50% or more. Several researchers have compared the percentage area reduction method with various techniques such as the diameter reduction method showing that the former is much accurate and reliable in identifying severe stenosis [21-23]. According to Von et al., more specific results were recorded with respect to sensitivity when employing surface ulceration than when applying neck pain scale.14 While another research concluded that the diameter reduction method was not as accurate in identifying severe stenosis as compared to the area reduction percentage method [23].

The findings of this study are consistent with previous research, revealing that most patients exhibited stenosis at the carotid bulb, aligning with earlier investigations. Studies by Nicholls et al. and Beizavi consistently identified the carotid bulb and internal carotid artery as the most commonly affected areas in patients with carotid artery stenosis [24,25]. These observations emphasize the importance of targeting carotid bulb stenosis in screening and treating carotid artery stenosis. The study advocates for the utility of carotid ultrasonography, particularly in high-risk patients, to identify plaque location and shape and assess the degree of stenosis. Given that most participants in the study were between the ages of 60 and 70, the study recommends duplex sonography screening for adults over 60 to detect potential issues early on in the extracranial carotid artery system.

The limitations of this study include small sample size limiting generalization of the findings. In addition, the study does not discuss whether the site or severity of CAS has any correlation with clinical outcome in patients presenting with acute ischemic stroke. It is therefore necessary to carry out future studies involving larger population samples and more comprehensive evaluations to look deeply into this complicated relationship between CAS and acute ischemic stroke.

## CONCLUSION

In conclusion, the study showed that 19% of the participants had CAS which was more frequent on the right than left. These results indicate how crucial contributing factor carotid artery stenosis is to acute ischemic stroke in at least one fifth of patients. In this respect, and considering early intervention, it suggests integrating CAS screening especially for the right side into strategies for treatment of patients suffering from acute ischemic stroke. In addition, comprehensive studies need to be conducted to identify potential causes and risk factors associated with carotid artery stenosis among this population.

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