

Carotid Artery Disease in Anterior Circulation Strokes; A Retrospective Analysis using Doppler Ultrasound

SARWAT IQBAL¹, SHAHZAD MAJEED BHATTI², MUJEEB UR REHMAN ABID BUTT³, FATIMA JAMIL⁴, FATIMA HABIB⁵, RAHEEMA KAINAT⁶

¹Assistant Professor Medicine, Shalamar Hospital Lahore

²Assistant Professor Cardiology, Fatima Jinnah Medical University, Sir Ganga Ram Hospital Lahore

³Professor of Medicine, Shalamar Hospital Lahore

⁴Medical Officer, Shalamar Hospital Lahore

⁵Medical Officer, Shalamar Hospital Lahore

⁶Physiotherapist, Shalamar Hospital Lahore

Corresponding author: Sarwat Iqbal, Email: saiqef@gmail.com

ABSTRACT

Background: Ischemic stroke is caused by carotid artery stenosis, often known as carotid artery disease. Stroke is thought to be the leading factor of impairment and the most prevalent and severe neurological condition. For the investigation of intracranial carotid artery disease CT angiography should be preferred.

Objective: To assess the carotid artery disease in anterior circulation strokes

Methodology: This retrospective study was carried out at the department of medicine, Shalamar Hospital Lahore for a period of two years from January 2019 to April 2021. Simple convenient sampling technique was employed. Totally 356 subjects fulfilling the inclusion criteria were enrolled in the current study. Carotid Doppler USG results were entered in the predesigned Performa. SPSS version 20 was used for analysis of data.

Results: In the current study, there were 198 (55.62%) males and 158 (44.38%) females. The average age of the subjects was 62.12 years with standard deviation of 13.1. Amongst the 356 subjects, less than 50% stenosis was observed in 296 (83.14%) patients in the right carotid, 50-69% stenosis in 40 (11.24%) subjects and more than 70% stenosis was observed in 20 (5.62%) subjects in the right carotid while in the left carotid, in 303 (85.11%), 35 (9.83%) and 18 (5.06%) patients, less than 50% stenosis, 50-69% stenosis and more than 70% stenosis was observed respectively.

Conclusion: Our study concludes that the frequency of carotid artery disease in anterior circulation strokes is high. For high-risk individuals, Doppler examinations are indicated for both primary and secondary prevention of ischemic stroke. For the investigation of intracranial carotid artery disease CT angiography should be preferred.

Key words: Carotid artery disease; Anterior circulation strokes; Doppler ultrasound

INTRODUCTION

Carotid artery stenosis is a constriction of the carotid arteries. These arteries provide the brain with its primary blood supply. Ischemic stroke is caused by carotid artery stenosis, often known as carotid artery disease¹. Stroke is thought to be the leading factor of impairment and the most prevalent severe neurological condition². 80% of strokes are caused by atherosclerosis of intracranial and extracranial arteries, which results in cerebral infarction³. Diabetes mellitus, hyperlipidemia, smoking, hypertension and coronary artery disease are all risk factors for ischemic strokes⁴. High degree stenotic patients have a higher risk of ischemic stroke; those with a 75 percent stenosis have a 37.4 percent two-year risk of ipsilateral stroke, while those with a 95 percent stenosis have a 96.3 percent two-year risk⁵. According to the World Health Organization, 2nd major cause of death will be stroke, behind ischemic heart disease, in both industrialized and underdeveloped nations by 2020². Patients had an increased risk of stroke during first 3 months following a transient ischemic attack, according to research⁶. The carotid bifurcation is often implicated by atherosclerotic plaque found distal to the carotid arteries' origin⁷. A high level of stenosis of internal carotid artery⁸, which may be readily diagnosed by Doppler ultrasonography but is not regularly done, is thought to be a major risk factor for Cerebrovascular Accident development. According to the study carried out by Hadi NU et al., carotid artery stenosis is seen in 56 percent of ischemic stroke patients as evaluated by Doppler ultrasonography⁸. Incidence of Stroke in Pakistan is estimated to be 250 per 100,000 people, implying that 350,000 new patients of stroke are diagnosed each year². The severity of stenosis of carotid artery determines how patients with carotid lesions are treated. Carotid doppler ultrasonography has essentially supplanted angiography in the detection of suspected carotid artery atherosclerosis in the cervical portion of the carotid artery⁹. Ultrasonography is a precise and reliable means of measuring stenosis. Ultrasound quantification is influenced by velocity and morphology, color Doppler, B mode, and spectral waveform¹⁰. The primary goal of carotid imaging is to provide

timely detection, diagnostic staging, surgery workup, and post-operative monitoring of therapy¹. In the assessment of extracranial carotid arteries, Doppler ultrasonography is a safe, economic, noninvasive and extremely useful technique. Carotid Doppler measures the level of stenosis, defines the plaque, and detects plaques at increased risk of embolization and intra-plaque bleeding¹¹. Because individuals with severe stenosis have a higher risk of cerebral infarction, it is vital to get the diagnosis accurately¹¹⁻¹³. This study was carried out to assess the carotid artery disease in anterior circulation strokes by using Doppler ultrasound.

MATERIALS AND METHODS

This retrospective study was carried out at the department of medicine, Shalamar Hospital Lahore. The duration of study was two years from January 2019 to April 2021. The study approval was taken properly from the ethical and research committee of the institute. All the subjects of both the gender age having age 18-65 years presenting with stroke consistent with anterior circulation territory who underwent Doppler USG study of carotids were included in the current study while all the patients with h/o carotid endarterectomy in past and patients having stroke due to non-atherosclerotic etiology were excluded from the study. Simple convenient sampling technique was employed. Totally 356 subjects fulfilling the inclusion criteria were enrolled in the current study.

Carotid Doppler USG results were entered into the Performa. Parameters included were mean intimal medial thickness in both common carotid arteries along with peak systolic and end diastolic velocities in both common carotid and internal carotid arteries. Percentage of stenosis was calculated from ICA/CCA PSV ratio. Carotid disease was diagnosed as presence of intimal thickness >1mm or ICA/CCA PSV ration of > 2 or any percentage of stenosis according to previous study³. SPSS version 20 was used for data analysis. Frequencies were calculated for gender and presence of carotid artery disease.

Mean/standard deviations were calculated for intimal medial thickness and percentage of stenosis.

RESULTS

In the current study, a total of 356 patients diagnosed with acute ischemic stroke at the department of medicine, Shalamar Hospital Lahore from January 2019 to April 2021 were included. There were 198 (55.62%) males and 158 (44.38%) females in our study. The average age of the subjects was 62.12 years with standard deviation of 13.1. The age of the youngest participant was 31 years while the age of eldest subject was 100 years. Most of the subjects were in the age group 61-71 years. The number of patients in age group ≤40 years, 41-50 years, 51-60 years, 61-71 years, 71-80 years and 81-90 years were 9 (2.53%), 71 (19.94%), 89 (25%), 90 (25.28%), 71 (19.94%) and 35 (9.83%) subjects respectively. The different risk factors observed in our study were diabetes mellitus in 18 (5.06%) subjects, hypertension in 27 (7.58%) subjects, cerebrovascular accident in 22 (6.18%) subjects, chronic kidney disease in 3 (0.84%) subjects, ischemic heart disease in 8 (2.25%) patients while myocardial infarction was observed in 1 (0.29%) patient. (Table 1) Based on the ICA/CCA PSV ratio, on the right carotid artery, 316 (88.76%) patients were observed with less than 2 ICA/CCA PSV ratio, 25 (7.02%) were between 2-4 and no flow was observed in 15 (4.215) patients while on the left carotid artery 335 (94.10%) patients were observed with less than 2 ICA/CCA PSV ratio, 16 (4.49%) subjects between 2-4 and no flow was observed in 5 (1.40%) patients. (Figure 1) Amongst the 356 subjects, less than 50% stenosis was observed in 296 (83.14%) patients in the right carotid, 50-69% stenosis in 40 (11.24%) subjects and more than 70% stenosis was observed in 20 (5.62%) subjects in the right carotid while in the left carotid, in 303 (85.11%), 35 (9.83%) and 18 (5.06%) patients, less than 50% stenosis, 50-69% stenosis and more than 70% stenosis was observed respectively. (Figure 2) The mean (SD) IMT for right carotid was 0.79 (0.29) cm while mean (SD) IMT for left carotid was 0.83 (0.35) cm. (Figure 3)

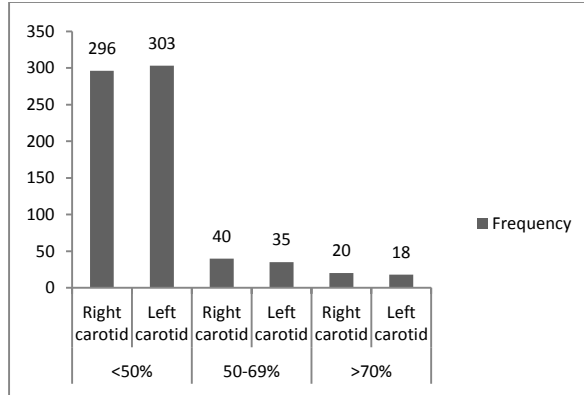


Figure 2: Percentage of stenosis on both right and left carotid artery

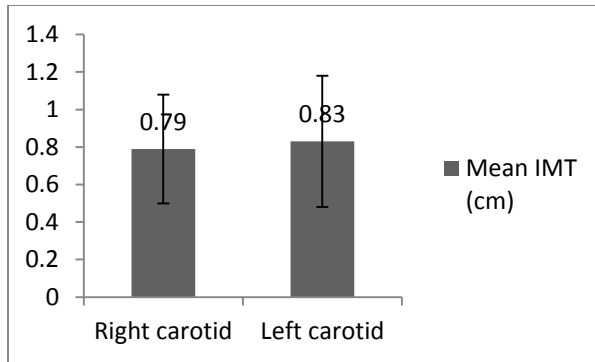


Figure 3: Mean IMT (cm) on both right and left carotid artery

Table 1: Clinical and demographic parameters of the subjects

Parameter	Category	Frequency (Percentage)
Gender	Male	198 (55.62%)
	Female	158 (44.38%)
Age group	≤40 year	9 (2.53%),
	41-50 year	71 (19.94%),
	51-60 year	89 (25%),
	61-71 year	90 (25.28%),
	71-80 year	71 (19.94%),
	81-90 year	35 (9.83%)
Risk factors	Diabetes mellitus	18 (5.06%)
	Hypertension	27 (7.58%)
	Cerebrovascular accident	22 (6.18%) subjects
	Chronic kidney disease	3 (0.84%)
	Ischemic heart disease	8 (2.25%)
	Myocardial infarction	1 (0.29%)

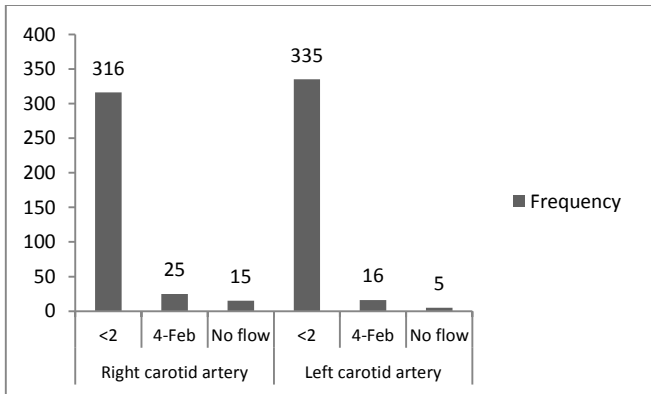


Figure 1: ICA/CCA PSV ratio, on both right and left carotid artery

DISCUSSION

The importance of carotid lesions in ischemic stroke patients has been shown in large multicenter observational trials like the North American Symptomatic Carotid Endarterectomy Trial¹⁴. With the severity of carotid stenosis, the risk of an ischemic stroke rises¹⁵. The early detection and correct measurement of the severity of the stenosis of carotid artery is an important risk-factor in the management of patients with symptomatic internal carotid artery blockage and reduced cerebral blood flow, with proper medication or surgical intervention for future ischemic infarcts¹⁶. In the current study, there were 198 (55.62%) males and 158 (44.38%) females in our study. In our study males were predominant like a previous study in which 62.7% subjects were male¹⁷. Similar to our study, another study also reported male predominance (72%) in their study³. These results are also consistent with data from population-based research, which show that men had more ischemic stroke cases than women^{18,19}.

In our study, the average age of the subjects was 62.12 years with standard deviation of 13.1. The age of the youngest participant was 31 years while the age of eldest subject was 100 years. Most of the subjects were in the age group 61-71 years. The number of patients in age group ≤40 years, 41-50 years, 51-60 years, 61-71 years, 71-80 years and 81-90 years were 9 (2.53%), 71 (19.94%), 89 (25%), 90 (25.28%), 71 (19.94%) and 35 (9.83%) subjects respectively. A previous study reported Mwazo in 2007 reported a mean age of 60 years¹⁷. Another study carried out by Fernandes et al. reported that age group 60-79 years has more patients with stroke³. The thickness of the carotid intima media is an indirect sonographic measure of the extent of end-organ atheromatous vascular disease. Adaptive media layer hypertrophy is linked to CIMT²⁰. Increased thickness of Carotid intima media measures have been linked to a higher risk of stroke, suggesting that they might be utilized as a diagnostic marker for stroke prediction according to the study of Kumar and colleagues²¹. In the current research, the mean (SD) IMT for right carotid was 0.79

(0.29) cm while mean (SD) IMT for left carotid was 0.83 (0.35) cm. These results are comparable with other studies^{21, 22}. In the current study, the different risk factors observed in our study were diabetes mellitus in 18 (5.06%) subjects, hypertension in 27 (7.58%) subjects, cerebrovascular accident in 22 (6.18%) subjects, chronic kidney disease in 3 (0.84%) subjects, ischemic heart disease in 8 (2.25%) patients while myocardial infarction was observed in 1 (0.29%) patient. These findings are comparable with another study who reported hypertension and diabetes mellitus as major risk factors⁸. Amongst the 356 subjects, less than 50% stenosis was observed in 296 (83.14%) patients in the right carotid, 50-69% stenosis in 40 (11.24%) subjects and more than 70% stenosis was observed in 20 (5.62%) subjects in the right carotid while in the left carotid, in 303 (85.11%), 35 (9.83%) and 18 (5.06%) patients, less than 50% stenosis, 50-69% stenosis and more than 70% stenosis was observed respectively. This is in contrast to the previous study, which found that 1.6 percent of people had substantial stenosis and 3.9 percent had moderate stenosis¹⁷. In a similar study conducted in Egypt, the percentage of patient populations with significant stenosis was found to be 9.3% both for moderate and severe stenosis²³. According to the results of a research conducted in Nepal in 2020, the number of patients with stenosis was much higher, with 18% having moderate stenosis, 8.9% having severe stenosis, 2.5% having near entire occlusion, and 3.8% having total occlusion²⁴. In our study, the frequency of more than 70% stenosis is lower by using Doppler ultrasound. This might be due to the fact there is no trend of using CT angiography for carotid artery diseases. For the investigation of intracranial carotid artery disease CT angiography should be preferred.

CONCLUSION

Our study concludes that the frequency of carotid artery disease in anterior circulation strokes is high. For high-risk individuals, Doppler examinations are indicated for both primary and secondary prevention of ischemic stroke. Color Doppler evaluation is a cost-effective, safe, repeatable, and time-saving way of determining the source of cerebrovascular insufficiency in the extracranial carotid artery system and guiding treatment options. For the investigation of intracranial carotid artery disease CT angiography should be preferred.

REFERENCES

- Afridi A, Afridi Z, Afridi F, Afridi A. Frequency of carotid artery stenosis in ischemic stroke patients. *J Med Sci*. 2017;25(3):340-3.
- Shaikh NA, Bhatti S, Irfan M, Khatri G, Vaswani AS, Jakhriani N. Frequency, characteristics and risk factors of carotid artery stenosis in ischaemic stroke patients at Civil Hospital Karachi. *JPMA*. 2010;60(8).
- Fernandes M, Keerthiraj B, Mahale AR, Kumar A, Dudekula A. Evaluation of carotid arteries in stroke patients using color Doppler sonography: A prospective study conducted in a tertiary care hospital in South India. *International Journal of Applied and Basic Medical Research*. 2016;6(1):38.
- Sharma R, Mattoo P. Colour Doppler study of extracranial carotid arteries in stroke. *JK Science*. 2015;17(2):88.
- 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 Applied Sciences Journal*. 2013;23(1):24-8.
- Bhatti T, Harradine K, Davies B, Earnshaw J, Heather B. Urgent carotid endarterectomy can reduce the risk of stroke after a TIA. *Br J Surg*. 1999;86(1):699.
- WJ Z, Zwiebel WJ. Venous thrombosis. Introduction to vascular ultrasonography 4th edition. Philadelphia: WB Saunders Company; 2000.
- ul Hadi N, Khan R, Awan KH, Iqba N. Frequency of carotid artery stenosis in ischemic stroke by using carotid doppler ultrasonography in a teaching hospital. *Gomal Journal of Medical Sciences*. 2009;7(2).
- Deurdulian C, Emmanuel N, Tchelep H, Grant EG, Malhi H. Beyond the bifurcation: there is more to cerebrovascular ultrasound than internal carotid artery stenosis! *Ultrasound quarterly*. 2016;32(3):224-40.
- Gautier C, Leclerc X, Pruvo J, Deklunder G. The role of carotid and transcranial Doppler sonography in the management of ischemic stroke. *J Radiol*. 2005;86(9 Pt 2):1105-14.
- Bluth EI, editor Evaluation and characterization of carotid plaque. *Seminars in Ultrasound, CT and MRI*; 1997: Elsevier.
- Fontenelle LJ, Simper SC, Hanson TL. Carotid duplex scan versus angiography in evaluation of carotid artery disease. *The American surgeon*. 1994;60(11):864-8.
- Gyawali M, Sharma P, Karki D. Study of Carotid doppler in Patients with ischemic stroke. *Journal of Brain and Spine Foundation Nepal*. 2021;2(1):24-30.
- Tan TY, Chang KC, Liou CW, Reynolds PS, Tegeler CH. Lack of Relation Between Severity of Stroke and Severity of Extracranial Internal Carotid Artery Lesions in Taiwanese First-Ever Ischemic Stroke Patients. *J Neuroimaging*. 2001;11(4):381-4.
- Lastas A, Graziene V, Barkauskas E, Salkus G, Rimkevicius A. Carotid artery atherosclerotic plaque: clinical and morphological-immunohistochemical correlation. *Medical Science Monitor: International Medical Journal of Experimental and Clinical Research*. 2004;10(11):CR606-14.
- Billir J, Thies WH. When to operate in carotid artery disease. *Am Fam Physician*. 2000;61(2):400-6.
- Mwazo MK. Prevalence Of Carotid Artery Stenosis And It's Risk Factors In Patients With Ischaemic Stroke As Seen In Kenyatta National Hospital: University of Nairobi; 2007.
- Kapral MK, Fang J, Hill MD, Silver F, Richards J, Jaigobin C, et al. Sex differences in stroke care and outcomes: results from the Registry of the Canadian Stroke Network. *Stroke*. 2005;36(4):809-14.
- Simpson CR, Wilson C, Hannaford PC, Williams D. Evidence for age and sex differences in the secondary prevention of stroke in Scottish primary care. *Stroke*. 2005;36(8):1771-5.
- Touboul P-J, Hennerici M, Meairs S, Adams H, Amarenco P, Desvarieux M, et al. Mannheim intima-media thickness consensus. *Cerebrovasc Dis*. 2004;18(4):346-9.
- Kumar P, Sharma R, Misra S, Kumar A, Nath M, Nair P, et al. CIMT as a risk factor for stroke subtype: A systematic review. *Eur J Clin Invest*. 2020;50(11):e13348.
- Osawa K, Trejo MEP, Nakanishi R, McClelland RL, Blaha MJ, Blankstein R, et al. Coronary artery calcium and carotid artery intima-media thickness for the prediction of stroke and benefit from statins. *European journal of preventive cardiology*. 2018;25(18):1980-7.
- El Hady A, Mohammad HS, Elkhatib T, Khalil GA. Assessment of Extracranial Carotid Arteries in Acute Ischemic Stroke: Correlation with Risk Factors. *International Journal*. 2019;7(1):1-6.
- Yadav AK, Dev B, Taparua S, Yadav N, Upadhyaya BB, Kumar P, et al. Role of Color Doppler Ultrasonography in Evaluation of Extracranial Carotid Artery in Stroke Patients: A Prospective Study. *Birat Journal of Health Sciences*. 2020;5(2):1091-8.