Original Research Article

Carotid doppler ultrasonography evaluation in patients with stroke

K. Karthick[1], J. A. Vasanthakumar[2]*

[1]Assistant Professor, [2]Associate Professor
Department of General Medicine, Government Dharmapuri Medical College, Dharmapuri, India
*Corresponding author email: **drvasanath.kumar@gmail.com**

International Archives of Integrated Medicine, Vol. 5, Issue 3, March, 2018.

Available online at http://iaimjournal.com/
ISSN: 2394-0026 (P) **ISSN: 2394-0034 (O)**
Received on: 15-02-2018 **Accepted on:** 23-02-2018
Source of support: Nil **Conflict of interest:** None declared.
How to cite this article: K. Karthick, J. A. Vasanthakumar. Carotid doppler ultrasonography evaluation in patients with stroke. IAIM, 2018; 5(3): 23-29.

Abstract

Introduction: Stroke is defined as rapid onset of focal neurological deficit resulting from diseases of cerebral vasculature and its contents. Community surveys in India have shown a crude prevalence rate for hemiplegia in the range of 200 per 100,000 persons, nearly 1.5% of all urban hospital admission, 4.5% of all medical and around 20% of neurological cases.

The aim of the study: To determine the usefulness of doing Carotid Doppler Ultrasonography as a screening procedure in predicting the chance of developing stroke in persons having risk factors for stroke.

Materials and methods: The study was conducted in Department of Medicine, Government Dharmapuri Medical College, Dharmapuri in December 2017 to January 2018. In this study, patients who were admitted with a history of sudden onset of neurological illness are subjected to CT scan brain. Among the patients who had suffered an ischemic stroke in the anterior circulation are selected and they were further evaluated.

Results: Hypertension was present equally in 58% of the males and females studied. Hence this study confirmed that hypertension is one of the major risk factors for the development of stroke and control of hypertension will reduce the risk of developing stroke. In this study diabetes as a risk factor was present in 89% of females and 41% of males. Hence this study observed that patients with diabetes are at increased risk for all forms of ischemic stroke and also are more likely to have hypertension and hyperlipidemia. Information from other studies also suggests that higher total and low-density lipoprotein (LDL) cholesterol levels are associated with an increased risk of ischemic stroke.

Conclusion: Carotid Doppler Ultrasonography cannot substitute for angiography as the sole preoperative tests for Carotid endarterectomy. However, it can be used as a screening test for the detection of the asymptomatic Carotid disease in patients with risk factors for stroke.

Key words

Carotid Doppler, Stroke, Dyslipidemia, Hypertension.

Introduction

A stroke or cerebrovascular accident is defined as abrupt onset of a neurological deficit that is attributed to a focal vascular cause. Thus the definition of stroke is clinical, and laboratory studies indicating brain imaging are used to support the diagnosis [1]. The clinical manifestations of stroke are highly variable because of the complex anatomy of the brain and its vasculature [2]. Cerebral ischemia is caused by a reduction in blood flow that lasts longer than several seconds [3]. Neurologic symptoms manifest within seconds because neurons lack glycogen and energy failure is rapid [4]. When blood flow is restored quickly brain tissue can recover fully and the patient's symptoms are only transient [5]. This is called a transient ischemic attack. Typically the signs and symptoms of the transient ischemic attack last for 5 to 15 minutes but by definition, it should be less than 24 hours [6]. If the cessation of blood flow lasts for more than a few minutes, infarction or death of the brain tissue occurs. If the signs and symptoms last for more than 24 hours it is termed as stroke. Stroke is one of the leading causes of mortality and morbidity [7]. Ischemic infarcts account for 80-85% of all strokes. Stroke-related neurological disability has a major impact on the patient, family members, and caretakers. 17% will remain institutionalized and 25-30% will need moderate to total assistance for activities of daily living [8]. Carotid atherosclerosis is one of the main risk factors for ischemic stroke which accounts for 5-10% of all ischemic stroke. Carotid endarterectomy has been shown to effectively reduce the risk of developing stroke in patients with significant stenosis i.e. 70% or more [9]. Various non-invasive vascular techniques can now be used to evaluate Carotid atherosclerosis which includes Carotid Doppler Ultrasonography, transcranial Doppler, CT angiography, Magnetic Resonance angiography, contrast-enhanced Magnetic Resonance Angiography [10].

Materials and methods

The study was conducted in the Department of Medicine, Government Dharmapuri Medical College, Dharmapuri in December 2017 to January 2018.

Inclusion criteria: Patients who suffered an ischemic stroke in the anterior circulation of the brain as confirmed by CT scan brain.

Exclusion criteria: Patients who suffered a stroke due to intracerebral hemorrhage, patients who suffered a stroke due to head injury.

In this study patient who was admitted with a history of sudden onset of neurological illness were subjected to CT scan brain. Among them, patients who had suffered an ischemic stroke in the anterior circulation were selected and they were further evaluated in the following ways: Detailed history taking for the evaluation of risk factors such as hypertension, diabetes mellitus, smoking, previous TIA, previous stroke and coronary artery disease, Complete physical examination to know the type of cerebrovascular accident (for right / left hemiplegia) and carotid artery examination for the presence of bruit, laboratory investigation which included blood sugar, serum total cholesterol, ECG and carotid Doppler ultrasonography.

Method of examination of carotid arteries

Carotid artery examination was performed with the patient in supine position, with the neck slightly extended and the head turned away from the side being examined. A 5 MHz transducer was used. The grayscale examination was begun in the transverse projection. The transducer was applied either from the anteromedial or lateral side of the sternocleidomastoid muscle. Scans were obtained along the entire course of the cervical carotid artery from the supraclavicular notch cephalad to the angle of the mandible. Origin of the common carotid artery was identified by the inferior angulation of the transducer. The carotid bulb was identified by

looking for mild widening if the common carotid artery at its bifurcation. Any anomalies in the bifurcation and the tortuosity were identified**.** The longitudinal view of the normal carotid arterial wall demonstrated two parallel echogenic lines. Inner line was a lumen-intima interface. The outer line was media-adventitia interface. The distance between these lines was measured and the thickness was called Intimal. Among the tests, carotid doppler ultrasound is a non-invasive, cost-effective and easy available mode of investigation to identify the patients with significant stenosis and other changes due to atherosclerosis. Since the non-invasive tests were used for preliminary screening before doing carotid endarterectomy the value of the tests lies in their ability to accurately identify patients with significant stenosis. However, newer studies of older technologies and the emergence of new non-invasive tests justify a revaluation of published data about the noninvasive testing of carotid arteries. The purpose of this study was to estimate retrospectively the various changes in carotid arteries by doppler ultrasonography in patients who had already suffered a stroke, which in turn determine the value of using carotid doppler ultrasonography as a modality of test to screen for atherosclerosis and the risk of developing stroke in people with risk factors for stroke. The artery was then searched for the presence of plaques and the plaques were classified into four types based on its echogenicity. The examination plane necessary for optimal longitudinal scans of the carotid artery to perform doppler spectral analysis was determined by the course of the vessels demonstrated in the transverse study. Images were obtained to display the relationship of both branches of the carotid bifurcation to the visualized plaque disease and the extent of the plaque was measured.

Results and Discussion

This study retrospectively assessed the changes in the carotid arteries by means of Doppler ultrasound in patients who had suffered a stroke. In this study, 50 patients were included of which 31 were males and 19 were females [11]. The study group is selected among the patients who were admitted with a history of sudden onset of weakness of right or left half of the body. The selected patients were subjected to CT scan brain. Among the patients who were having an infarct in the anterior circulation of the brain were further evaluated for the identification of risk factors which included hypertension, diabetes, smoking, and hypercholesterolemia [12]. The patients with hemorrhagic stroke and those patients with a definite history of head injury were excluded [13]. The patients were then subjected to carotid Doppler ultrasonography both on the ipsilateral and also on the contralateral side of the lesion shown in CT scan brain as per the age and sex of the patients as shown in **Table - 1** and **Table - 2**. 44% of them were between 51-60 years with an almost equal number of males and females. 72% of them were above 50 years and 28% were below 50 years [14]. Most of the patients below 50 years are males. Hence this study shows that male sex and increased age are the important risk factors for the development of stroke. This has been observed in other studies also [15]. As per the other risk factors are concerned as shown in **Table – 3**, hypertension was present equally in 58% of the males and females studied. Hence this study confirmed that hypertension is one of the major risk factors for the development of stroke and control of hypertension will reduce the risk of developing stroke [16]. The stroke prevention benefits of antihypertensive drug therapy are continuous across the usual range of blood pressures, and the relative benefits for each mm Hg reduction in blood pressure are similar regardless of the baseline systolic blood pressure (i.e., whether the systolic blood pressure is 170 mm Hg or 150 mm Hg).thus, there does not appear to be a j curve in antihypertensive drug efficacy [17]. In this study diabetes as a risk factor was present in 89% of females and 41% of males. Hence this study observes that patients with diabetes are at increased risk for all forms of ischemic stroke and also are more likely to have hypertension and hyperlipidemia [18]. However, no high-quality evidence supports the reduction

of stroke risk through improved glucose control. The three major randomized trials that have tested the glucose-control hypothesis demonstrated no significant reductions in the risk of ischemic stroke or any other macrovascular outcome. Nonetheless, several guidelines recommend tight glucose control to reduce the development or progression of microvascular complications in patients with type 1 or type 2 diabetes [19]. Because hypertension, hyperlipidemia, and type 2 diabetes (or at least glucose intolerance) frequently coexist, which is also evident in this study as shown in **Table - 5** in which 50% of them are having more than one risk factor it is important to screen patients with any one of these risk factors for the other factors and to institute aggressive risk-factor modification for all three conditions to prevent a wide variety of atherosclerotic events [20]. In particular, aggressive blood pressure reduction (to a target of less than 130/80 mm Hg) is important in patients with diabetes. In this study smoking as a risk factor was present in 83% of males and none of the female patients in the study were smokers [21]. While obesity, lack of regular aerobic exercise, excessive alcohol intake, and smoking all increase the risk of stroke, no high-quality randomized trials have evaluated the effects that modifications of these factors have on stroke risk. However, given the strength of observational data and the overall health benefits of weight loss, alcohol restriction, regular aerobic physical activity, and smoking cessation, these lifestyle modifications should be discussed and encouraged. In this study, hypercholesterolemia was present in 64% of males and 68% of the females as shown in **Table - 4**. Information from other studies also suggests that higher total and low-density lipoprotein (LDL) cholesterol levels are associated with an increased risk of ischemic stroke [22]. While most individual trials of lipid-lowering therapies (e.g., resins, fibrates, dietary measures) have not shown a decreased risk of stroke, a meta-analysis of 11 trials found that treatment with statins (3-hydroxy-3-methylglutaryl coenzyme A reductase inhibitors) is associated with a 25 percent reduction (95 percent CI, 14 to 35 percent) in the risk of fatal and nonfatal stroke. It has also been observed in our study that 34% of the patients having normal cholesterol level even though they are having evidence of atherosclerosis as shown by Carotid Doppler Ultrasonography as increased intimal medial thickness. Hence it is not clear whether reduction of cholesterol level has any effect on the cervical or intracranial atherothrombotic processor on stroke risk. However, it requires further studies. It has been observed in this study as shown in **Table - 5** that the auscultation of carotid arteries shows bruit in only 10% of patients this may be because most of them are having stenosis of less than 50%. It has been shown in other studies that neck bruits do not reliably predict presence or absence of underlying occlusive Carotid disease. Cervical bruits may be due to other causes such as transmitted cardiac murmurs, anatomic variations, tortuosity, and hyperdynamic states [23]. Studies looking at the relationship between Carotid bruit and corresponding stenosis have used different methodologies which limits comparability (populations with different prevalence of vascular disease, inter observer variability among clinicians about auditory characteristics of the bruit, different methods of imaging and different definition of Carotid lesion severity). Depending on the method of assessment, the predictive value of a Carotid bruit for ipsilateral moderate to severe stenosis ranges from approximately 16% to 75%. Patients with asymptomatic bruits are less likely to have an underlying stenosis than patients with symptomatic bruits. According to some, among patients with asymptomatic neck bruits, 17% had a >75% stenosis, while in patients with both carotid stroke and bruits, 60% had75% stenosis. Conversely, many patients with a high grade stenosis do not have a cervical bruit. Hence it is said that Carotid bruit do not reliably predict or exclude carotid occlusive disease [24]. Out of the 21 patients (42%) showed only increased intima-media thickness without any plaques. Hence increased intima-media thickness alone without any visible plaques can be taken as one of the risk factor for developing stroke. This has been proved in other studies [25]. Number of patients

with changes in contralateral carotid artery was as per **Table – 6**.

Table – 1: Various risk factors which contributed to stroke.

Risk factor	Male	Female
Hypertension	18 (58%)	13 (58%)
Diabetes mellitus	13 (41%)	17 (89%)
Smoking	26 (83%)	---
Dyslipedemia	20(64%)	13(68%)

Table – 2: Relationship between serum-cholesterol level and stroke.

Total number	Raised total cholesterol	Normal total cholesterol
50	33(66%)	17(34%)

Table – 3: Presence and absence of carotid bruit.

Total no of patients	Bruit present	Bruit absent
50	5(10%)	45 (90%)

Table – 4: Various types of plaques seen are given.

Type of plaques	No of patients
No plaques with normal IM thickness	3 (6%)
Increased IM thickness (No plaques)	21(42%)
Type 1	12(24%)
Type 2	4(8%)
Type 3	9(18%)
Type 4	1(2%)

Table – 5: Percentage of stenosis detected by doppler spectral analysis.

Percentage of Stenosis	No of Patients	
More than 70%	1	(2%)
50 – 70%	10	(20%)
Less than 50%	36	(72%)
Normal	3	(6%)

Conclusion

Doppler Ultrasonography of carotid arteries shows significant changes due to atherosclerosis in the patients who suffered stroke. Abnormalities in the vessel wall are more pronounced than the flow disturbances due to stenosis. Since most of the patients showed changes in the contralateral sides and ECG changes suggestive of ischemic heart diseases it is taken as an evidence of generalized vascular disease due to atherosclerosis. Carotid Doppler Ultrasonography cannot substitute for angiography as the sole preoperative tests for Carotid endarterectomy. However it can be used as a screening test for the detection of the asymptomatic Carotid disease in patients with risk factors for stroke.

Table – 6: Number of patients showing changes in contralateral carotid artery.

Total no of patients	Changes in the contralateral carotid artery	Changes in the contralateral side
50	22(44%)	28(56%)

References

1. Rodgers A, MacMahon S, Gamble G, Slattery J, Sandercock P, Warlow C. Blood pressure and risk of stroke in patients with cerebrovascular disease. The United Kingdom Transient Ischaemic Attack Collaborative Group. BMJ, 1996; 313: 147.
2. Harrison's Principles of Internal Medicine, 16th edition, McGraw Hill, 2004, chapter 349, p. 2377.
3. David Sutton and Roger Gregson. Doppler ultrasound of the arteries, Textbook of radiology and imaging by David Sutton, Churchill Livingstone, sixth edition, 1998, volume1, p. 719-729.
4. Erricson SJ, Mewissen MW, Foley WB, et al. Stenosis of the internal Carotid artery: assessment using color Doppler imaging compared with angiography. AJR, 1989; 152: 1299-1305.
5. Grant EG, Benson CB, Moneta GL, et al. Carotid artery stenosis: gray-scale and Doppler ultrasound diagnosis--Society of Radiologists in Ultrasound consensus

conference. Ultrasound Q, 2003 Dec; 19(4): 190-8.

6. Growing B, Driesner F, Kallwellis G et al. Cerebrovascular disease assessed by color flow and power Doppler Ultrasonography. Stroke, 1996; 27: 95-100.
7. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). UK Prospective Diabetes Study (UKPDS) Group. Lancet, 1998; 352: 837-53.
8. Mackey A, Cote R, Battista RN. Asymptomatic Carotid disease. In: Canadian Task Force on the Periodic Health Examination. Canadian Guide to Clinical Preventive Health Care. Ottawa: Health Canada, 1994; 692-704.
9. MacMahon S, Peto R, Cutler J, Collins R, Sorlie P, Neaton J, et al. Blood pressure, stroke, and coronary heart disease. Part 1, prolonged differences in blood pressure: prospective observational studies corrected for the regression dilution bias. Lancet, 1990; 335: 765-74.
10. McAlister FA. Using evidence to resolve clinical controversies: is aggressive antihypertensive therapy harmful? Evidence-Based Med [United Kingdom], 1999; 4: 4-6.
11. Meinert CL, Knatterud GL, Prout TE, Klimt CR. A study of the effects of hypoglycemic agents on vascular complications in patients with adult-onset diabetes II Mortality results. Diabetes, 1970; 19 (suppl): 747-830.
12. Meltzer S, Leiter L, Daneman D, Gerstein HC, Lau D, Ludwig S, et al. 1998 clinical practice guidelines for the management of diabetes in Canada. Canadian Diabetes Association. CMAJ, 1998; 159(suppl 8): S1-29.
13. Middleton WD, Foley WD, Lawson TL. Colour flow Doppler imaging of Carotid artery abnormalities. AJR, 1988; 150: 419-425
14. Osborn Anne G. Brain. Cerebral vasculature; Normal vascular anatomy and pathology, chapter 6 & 11, Diagnostic Neuroradiology, AMIRSYS, 1st edition, 2017, p. 117-123 & 330-332.
15. P.M. Dalal. Cerebrovascular disorders, API textbook of medicine, 7th edition, p. 796.
16. Perry HM Jr, Davis BR, Price TR, Applegate WB, Fields WS, Guralnik JM, et al. Effect of treating isolated systolic hypertension on the risk of developing various types and subtypes of stroke: the Systolic Hypertension in the Elderly Program (SHEP). JAMA, 2000; 284: 465-71.
17. Peter Libby. The Pathogenesis of Atherosclerosis Harrison's Principles of Internal Medicine, 16th Edition, Volume II, Page 1425-29.
18. Psaty BM, Smith NL, Siscovick DS, Koepsell TD, Weiss NS, Heckbert SR, et al. Health outcomes associated with antihypertensive therapies used as first-line agents. A systematic review and meta-analysis. JAMA, 1997; 277: 739-45.
19. R.J. Sellar. Imaging blood vessels of the head and neck; Neurological investigations. Journal of neurology, neurosurgery and psychiatry BMJ, 1997.
20. Rajagopal, KV Bhushan, N Lashkar, Shekar Banavali, Nitin Kumar Singh. Pictorial Essay: Colour Duplex Evaluation of Carotid Occlusive Lesions; Indian Journal Radiology Imaging, 2000; 10.
21. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. The Diabetes Control and Complications Trial Research Group. N Engl J Med., 1993; 329: 977-86.
22. Wade S. Smith, S. Claiborne Johnston, J. Donald Easton; Carotid atherosclerosis. Harrison's Principles of Internal

Medicine, 16th edition, McGraw Hill, 2004.

23. Woolf SH, Davidson MB, Greenfield S, Bell HS, Ganiats TG, Hagen MD, et al. Controlling blood glucose levels in patients with type 2 diabetes mellitus. An evidence-based policy statement by the American Academy of Family Physicians and American Diabetes Association. J Fam Pract., 2000; 49: 453-60.
24. Wright JM, Lee CH, Chambers GK. A systematic review of antihypertensive therapies: does the evidence assist in choosing the first-line drug? CMAJ, 1999; 161: 25-32.
25. Zwiebel WJ, Knighton R. Duplex examination of Carotid arteries. Seminars in Ultrasound, CT and MR, 1990; 11: 97-135.