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Original Article

Evaluation of Extracranial Carotid Arteries in Ischemic Stroke Patients Using Color Doppler Sonography and Correlation with Various Risk Factors

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Abstract

Background

Cerebral ischemic stroke is the major cause of death after ischemic heart disease and malignancies, among which major cases of stroke results from atherosclerosis of intra and extra-cranial carotid vessels. The aim of this study is to evaluate the extracranial carotid arteries in patients with ischemic stroke and correlation with various risk factors.

Materials and Methods

A cross sectional study of the patients with ischemic stroke presented in Radiology department of Nobel Medical College were evaluated for a period of one year from February 2017- January 2018 using color Doppler ultrasound and correlated with various risk factors. A total of 50 patients were included in the study. All age groups and sex were included.

Results

Out of 50 patients, 29 patients (58%) were males and 21 patients (42%) were females. Stroke was present in 24 patients on right side and 26 patients on left side. A total of 36 patients had extra-cranial carotid stenosis. Among them, 18 patients had <50% stenosis, 17 patients had >50% stenosis and 1 patient had complete occlusion. The most common cause of obstruction was found to be atherosclerotic changes in the form of atheromatous plaque. Out of 50 patients 27 had history of hypertension and 19 had history of smoking. Out of 27 hypertensive patients, 23 had stenosis which is statistically significant (p value 0.024).

Conclusion

The current study shows the importance of color Doppler ultrasound as an economic, safe and non-invasive method of demonstrating the cause of stroke in extra-cranial carotid artery system.

Key words: *Hypertension, Stenosis, Stroke*

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Introduction

The major cause of death after ischemic heart disease and malignancies is cerebral ischemic stroke. Out of which cerebral infarction resulting from atherosclerosis of intra and extra-cranial carotid vessels accounts for 80% of strokes. It has been proven that after the first 3 months of transient ischemic attack, the risk of major stroke is higher [1]. 20% or more of strokes have been heralded by a TIA [2]. Depending upon etiology, stroke is classified into either hemorrhagic or ischemic accounting for 15% and 85% cases respectively [3, 4]. About 80% cases of stroke are due to thromboembolic events with the embolus arising from the carotid plaque[5]. Color Doppler ultrasound combined with high resolution imaging and spectral waveform analysis has proved to be non-invasive, safe and cost effective means of detecting extracranial carotid artery stenosis and also has replaced angiography for suspected extracranial carotid atherosclerosis [6].

Materials and Methods

This was a Cross sectional study conducted in Department of radio diagnosis and imaging, Nobel Medical College in a period of one year from February 2017- January 2018 after taking ethical clearance from institutional review committee. The study considers 95% confidence interval and 80% power to evaluate the sample size. According to the literature review risk factor for ischemic stroke was found to be hypertension, which is estimated approximately 40% among the cases. Now using the formula, $n= z^2 p q/l^2$ where Z= 1.96 at 95% confidence interval, p =40%, q=60% and l=20% of p i.e; 8. Putting in the formula n= 4x40x60/64 which is equal to 150. But according to patient presenting to radiology department it was approximately 50 cases that will be included during the study. Now using corrected sample size formula for finite population, Corrected sample size= calculated sample size/1+ calculated sample size/estimated population. Now using this formula 150/1+ 150/50= 150/4 which is approximately, 38.

Therefore this study included 50 cases for the study irrespective of age, sex, socio-economic status and ethnicity presented with clinical history and CT findings consistent with stroke were included in this study. Stroke of less than a week duration, head injury and hemorrhage was excluded from the study. Informed consent of every patient was taken. A detailed history was taken through questionnaire. Risk factors such as smoking, hypertension, dyslipidemia and diabetes were documented. The study required CT scan of brain, carotid Doppler, lipid profile, blood sugar and blood pressure measurement. CT scan was done in Siemens 128 slice scanner. Doppler ultrasound was done in Samsung HS 40 using 7.5MHz linear array transducer. Patient was kept supine with pillow under the neck to hyperextend the neck. The long axis and short axis views of the carotid arteries were evaluated. Posterolateral approach was used to visualize the carotid artery in long axis. Short axis views were obtained in anterior and lateral approach. All the Doppler examinations were performed by the same radiologist. On gray scale, presence or absence of plaque, its location and plaque characteristics like echogenicity and calcification were evaluated. On Doppler study, lumen diameter at most stenotic portion was evaluated. The collected data were analyzed with SPSS software version 20 and presented in the form of tables, figures and diagrams. Chi square test was applied to see the significant relationship between two variables.

Results

In this study, out of 50 patients, 29 patients (58.0%) were males and 21 patients (42.0%) were females (Fig 1). Out of 50 patients studied, 24 patients had stroke on right side and 26 patients had stroke on left side. A total of 36 patients had extra-cranial carotid stenosis. Out of 36 patients, 18 patients had <50.0% stenosis, 17 patients had >50.0% stenosis and 1 patient had complete occlusion (Fig 2) (Table 2). 18 patients had left sided stenosis and 14 patients had right sided stenosis and bilateral involvement was seen in 4 patients (Fig 3).

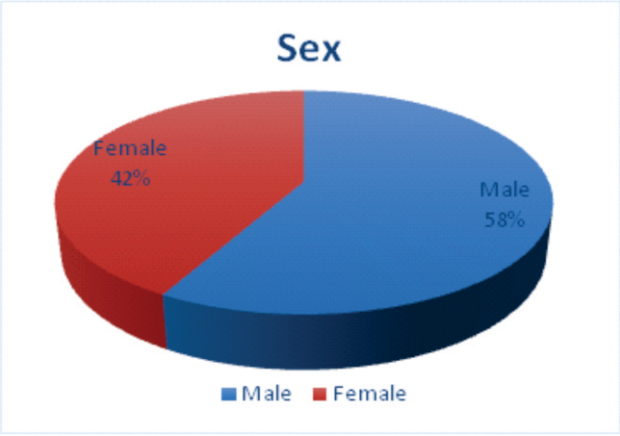

Figure 1: Sex distribution

The most common cause of obstruction was found to be atherosclerotic changes in the form of

atheromatous plaque. CCA was the most common location of the plaque followed by ICA, ICA and CCA both, carotid bifurcation and carotid bulb (Fig 4). Out of these plaques, 17 patients (47.0%) had Calcified plaque, 10 patients (28.0%) had homogeneous plaque and 9 patients (25.0%) had non homogeneous plaque (Fig 5) (Table 3). Hypertension and smoking were most prevalent risk factor for cerebral ischemic stroke(Fig 6). Out of 50 patients 27 had history of hypertension and 19 had history of smoking. Out of 27 hypertensive patients, 23 had stenosis (Fig 7) which is statistically significant (p value 0.024). 16 patients had history of diabetes mellitus and 7 patients had history of dyslipidemia. No significant association was seen between the stenosis and smoking, diabetes mellitus and dyslipidemia.

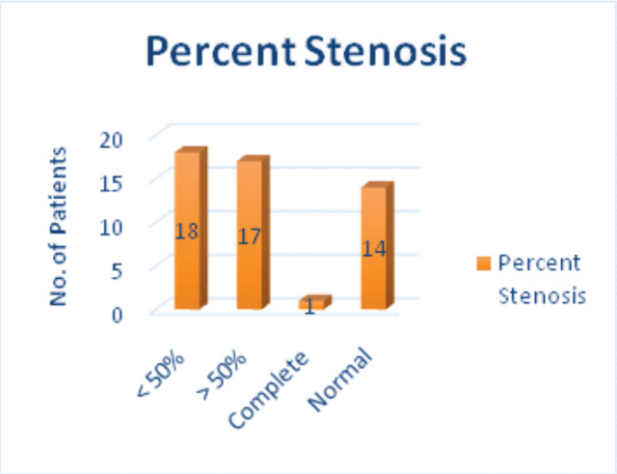

Figure 2: Patient with significant stenosis

Table 1: Age distribution

Age Range	No. of Patients
50-60	17
61-70	16
71-80	10
81-90	7
Total	50

Discussion

Atherosclerotic disease involving the extra-cranial carotid arteries accounts for 30 to 60% of strokes, usually within 2cm of the carotid bifurcation [7]. The plaque composition can be easily assessed by ultrasound. The detected plaque characteristics may help in surgical and medical planning and also may have prognostic value[8].

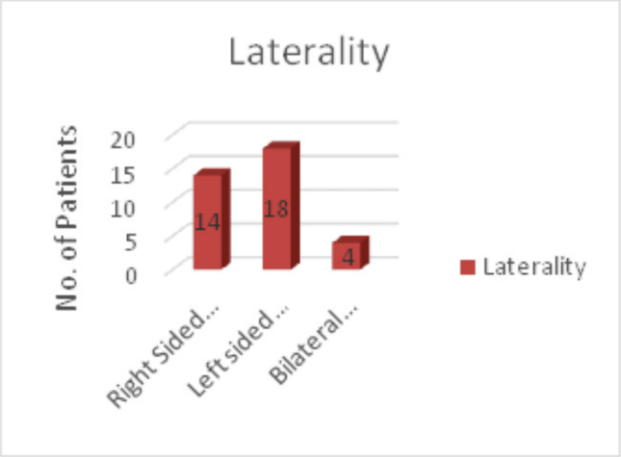

Figure 3: Laterality of stenosis

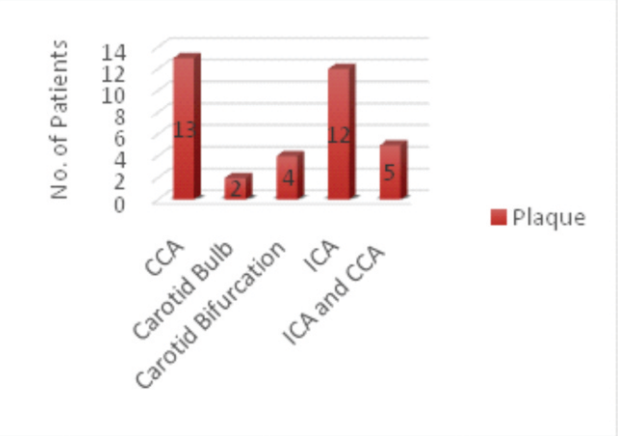

Figure 4: Site of distribution of plaque

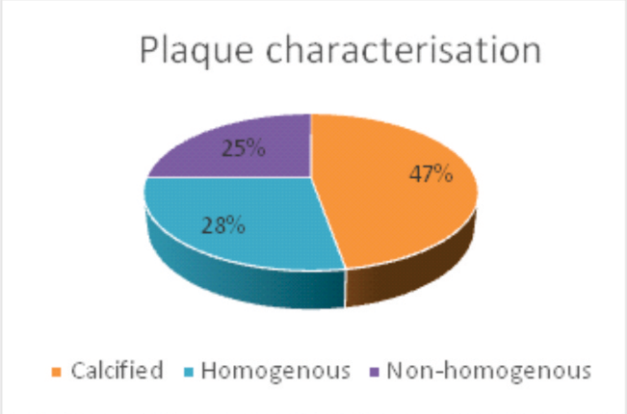

Figure 5: Plaque characterization

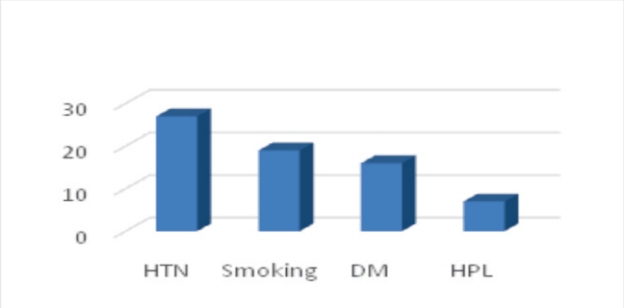

Figure 6: Risk factors

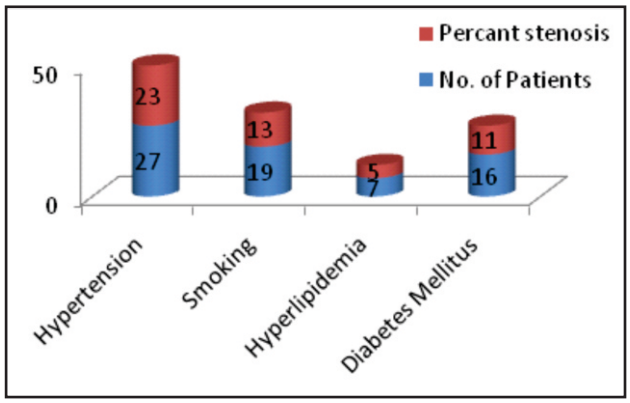

Figure 7: Risk factors with percentage stenosis

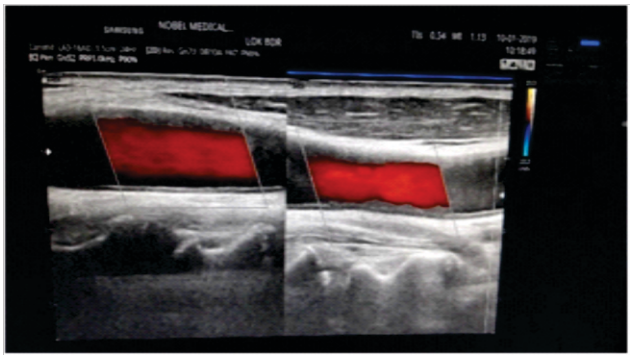

Figure 8: Non obstructing plaque in CCA

Table 2: Distribution of patients with maximum stenosis with age and sex.

Age	Sex	Percentage Stenosis			
		Complete	>50%	<50%	Normal
50-60	Male	1	3	3	3
	Female	0	3	1	3
61-70	Male	0	4	4	2
	Female	0	3	2	1
71-80	Male	0	1	3	1
	Female	0	1	3	1
81-90	Male	0	2	1	1
	Female	0	0	1	2

Table 3: Plaque characterization

Plaque Characterization	Laterality			
	Rt. side	Lt side	Bilateral	Normal
Calcified	5	8	4	0
Homogenous	4	6	0	0
Non-homogenous	5	4	0	0
Normal	0	0	0	14
Total	14	18	4	14

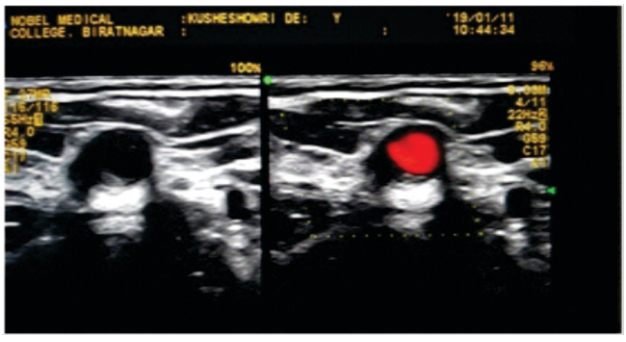

Figure 9: Non significant stenosis of CCA

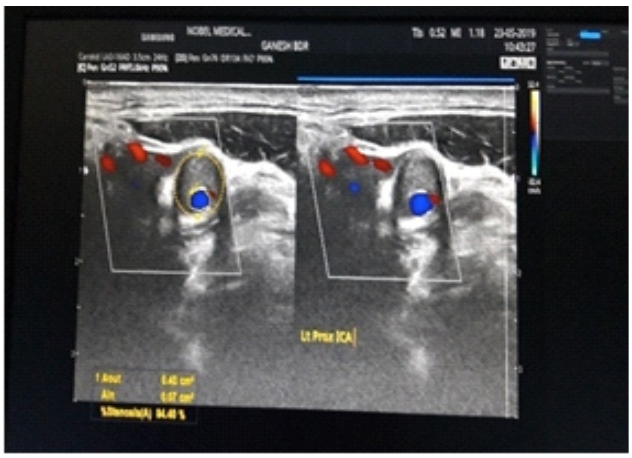

Figure 10: Significant stenosis at proximal ICA

In earlier studies, it was found that incidence of stroke increases after age of 60 years [9]. In our study, the highest incidence of stroke was found in the age group of 50-60 years (17/50) followed by 61-70(16/50) (Table 1). Iemolo et al. in his study showed that only 2.5% of stroke victims were females. In this study, 58% of the patients (29/50) were males and 42%of the patients were females (21/50). Garg S et al in their study found out smoking and heart disease showed maximum positive correlation with stenosis[10]. In our study hypertension showed statistical significance with the stenosis.

Lawes et al. studied 188,000 patients with hypertension out of which 6800 had stroke events [11]. In our study, of the 50 patients, 27(38%) patients were hypertensive out of which 23 had stenosis, which was statistically significant. There is a positive relationship between smoking and risk of stroke. It was estimated in an earlier study that 22% of stroke was attributable to smoking [12]. Our study found 19 patients with a history of smoking. Of them, 13 had significant stenosis.

Diabetes mellitus is another risk factor for atherosclerosis. Lindsberg and Roine observed that two-third of all ischemic stroke types on admission had diabetes mellitus[13]. In our study, 16 patients had diabetes mellitus of which 11 had significant stenosis.

Schulte-Altedorneburg et al. found steno occlusive carotid lesion in 64% of the patients studied. He also confirmed his findings by postmortem studies[14]. In our study, 36 patients had plaques in the carotid artery of which 14 patients had plaques on the right side, 18 patients had plaques on the left side and 4 patients had bilateral involvement. (Table 3). Carotid bifurcation is

commonly involved by the atherosclerotic plaque located distal to the origin of the carotid arteries [15]. In our study, CCA was found to be the commonest site affected by the plaque in 13 patients. In our study, 17 (47%) had calcified plaques, 10 (28%) patients had homogeneous plaques and 9(25%) patients had non homogeneous plaques.

During this study, difficulty in positioning was observed in unconscious patients. This resulted in difficulty in performing Doppler examinations. Among the patients with stenosis, large calcified plaques obscured the examination due to dense posterior acoustic shadowing.

Conclusion

In this study, hypertension and smoking were the most prevalent risk factors for stroke. Hypertension was statistically significant (p value 0.024) with stenosis of extra-cranial carotid artery stenosis. The most common site of plaque location was CCA and the most common plaque was calcified. Color Doppler ultrasound is an economic safe, non-invasive method of demonstrating the cause of stroke in extra-cranial carotid artery system. Our study highlights the importance of color Doppler ultrasound in stroke patients through surveillance of various risk factors that predisposes a person to cerebral ischemia. This might necessitates the routine screening of high risk patients to prevent the occurrence of stroke.

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