

CAROTID DOPPLER EVALUATION OF TRANSIENT ISCHEMIC ATTACK AND STROKE PATIENTS AND ITS CORRELATION WITH CT SCAN HEAD

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ABSTRACT

Background: Sonographic evaluation of the carotid arteries, both gray scale and doppler is widely used for risk assessment for cerebrovascular accidents.

Aims: Aim of this study was to evaluate stroke and transient ischaemic attack patients with carotid ultrasound for Intimal thickness, presence and characterization of plaque (type, surface and site), spectral waveform analysis with percentage of stenosis,

Materials and methods: This is a prospective study of 50 patients of cerebrovascular insufficiency who presented to the Radiology and Imaging During the period of 20 months of study, cases of cerebrovascular insufficiency were evaluated with colour Doppler sonography and CT.

Results: In our study of 50 cases, 30 were males and 20 were females with a male: female ratio of 3:2.26 patients had hemiparesis, 12 had hemiplegia, aphasia 4 patients and TIA seen in 5 patients. It is observed that IMT more than 0.8mm has high risk of CVA. In our study IMT more than 0.8mm was found in 35 pts(70%). Out of which 20pts were in age group of 60-69(57%), 10 patients in the age group of 50-59(28%), and 5 patients in age group of 40-49 (14%). Out of 100 vessels examined, significant stenosis i.e., $\geq 50\%$ stenosis was seen in 8 (8%) vessels on colour flow imaging. Out of the 8 vessels with significant stenosis 7 showed 50-69% stenosis, 1 showed $\geq 70\%$ stenosis. Based on the Peak systolic velocity ratio of ICA/CCA, 7 vessels showed

significant stenosis i.e, ratio > 2 . In 7 vessels the ratio was between 2-4, , in 1 vessels it was more than 4, Out of the 12cases with significant stenosis ($\geq 50\%$) , cases (75%) had a cortical infarct, two cases(16.6%) had a subcortical infarct.

Conclusions:Doppler sonography provides a rapid, non-invasive, relatively in expensive and accurate means of diagnosing carotid stenosis.

Keywords:Carotid angiography, Doppler sonography, subcortical infarct.

INTRODUCTION

Stroke or cerebrovascular disease is oneof the leading causeof death, ranking third behind only malignancies and cardiovascular disease. Many stroke victims survive the catastrophic event with some degree of neurological impairment more than 50,000 new cases of cerebrovascular accidents are reported annually, of which 80% of strokes are caused by Atherosclerosis, leading to cerebral infarction. Intracranial hemorrhage and subarachnoid hemorrhage account for the remaining 20%.

Atherosclerotic changes in the extracranial carotids is one of the causes leading to stroke, so early detection of these atheromatous changes in carotid arteries will help a great extent to reduce stroke and its related morbidity and mortality. Sonographic evaluation of the carotid arteries, both Gray scale and Doppler gives near accurate results and is widely available for their evaluation.

Carotid artery atherosclerosis could be a predisposing factor for TIA and the risk for major stroke is higher in the first three months after the episode.Sonography has largely replaced angiography for suspected extracranial carotid atherosclerosis[1,2]. Using duplex sonography, we graded thestenosis ,based on the luminal diameter of carotid occlusion into mild, moderate, severe, and complete, which have got implications related to management.

Carotid angiography is the gold standard for detecting the severity of carotid disease, but it has its drawbacks like, risk of radiation , invasive and costly procedure.. MR angiography is now used and gives similar or better results, especially useful for flow quantification, but at a much higher cost. Thus Doppler evaluation of the carotid arteries has been shown to be cost effective, non-invasive means of early detection of increased risk of CVAs with sensitivity approaching that of angiography.

MATERIALS AND METHODS

This is a prospectivestudy of 50 patients of cerebrovascular insufficiency who presented to the Radiology and Imaging Department referred mainly from the Departments of,general Medicine and Emergency medicine. This study was conducted during a period of 20 months from to January 2017 to June 2018. The study included 30 males and 20 females. Brief clinical history was taken with particular attention towards risk factors and clinical examination was performed

in all cases. Laboratory investigations like Random blood sugar, Serum cholesterol were recorded.

Ultrasound unit used was GE LOGIC P9.with 7.5 MHz linear array transducer.

The CT unit used was TOSHIBA SCANNER ALEXION TSX -032A

All patients with these criteria were subjected to CT scan of brain in the axial plane.. Patients who showed evidence of infarcts in the Vertebrobasilar territory, intracerebral haemorrhage, neoplasms and other causes of stroke were excluded from the study.

Carotid arteries were examined with the patient in the supine position with the head slightly extended and turned away from the site of examination. Exposure of the neck was maximized by having the patient to lower the shoulders.

RESULTS

In our study of 50 cases, 30 were males and 20 were females with a male: female ratio of 3:2

Table -1 - Age and symptoms distribution of cases

Age group (Years)	Males		Females	
	Number	Percentage	Number	Percentage
<40	2	6.6	0	0
40 – 49	5	16.5	1	5
50 – 59	10	33	4	20
60 – 69	15	46.2	10	50
70 – 79	8	26.6	5	25
≥ 80	0	0	0	0
Symptoms				
Hemiparesis	16	10	26	52
Hemiplegia	07	05	12	24
Monoparesis	0	0	0	0
Hemisensory loss	0	0	0	0
Aphasia	2	2	4	8

Amourosis fugax	0	0	0	0
Transient Ischemic Attack (TIA)	5	3	8	16

The 50 cases studied, 30 patients were male (60%) and 20 patients were female (40%). Majority of the male patients were in the age group of 60 – 69 year (46.5%) and 50% of female patients were in the age group of 60 – 69.

In the total 50 cases studied, 26 patients had hemiparesis, 12 had hemiplegia, aphasia 4 patients and TIA seen in 5 patients.

Table : 2 - Risk factor and site wise distribution of cases

Risk factors	Cases (n=75)	
	Number of cases	Percentage (%)
Smoking > 10 yrs	30	60
Hypertension	40	80
Diabetes mellitus	25	50
Hypercholesterolemia	25	50
Previous CVA	10	20
Site		
No Plaque	7	14
Right	20	40
Left	18	36
Bilateral	10	20
Total	58	100
Plaque Characterisation		
HOMOGENOUS	10	17.2
HETEROGENOUS	28	48.27
calcified	20	34.4

We found in our study of 50 cases, that hypertension was the commonest risk

factor(80%), followed by smoking for more than 10 years (50%), Hypercholesterolemia (50%), Diabetes mellitus (50%), previous CVA (20%).In our study of 50 patients, atheromatous plaque was found bilaterally in 10patients(20%), on the right side in 20 patients (40%) and on the left side in 18 patients (36%). No plaques were observed in 7 patients (14%). A total of 58 plaques were observed in the 100 vessels that were examined. 20PLAQUES were calcified(34.4%), 10 plaques were low echogenicity (17.2%),28 plaques were moderate echogenicity (48.2%),

Table : 3 - Distribution of atheromatous plaques according to site

Plaque Site	Right	Left	Total (n= 58)	
			Number	Percentage (%)
CCA	10	8	18	31%
Bulb	16	13	29	50%
ICA	7	4	11	19%

Of the 58 plaques,18 were located in common carotid artery (10 on the right and 8 on the left), 11 in internal carotid artery (7 on the right and 4 on the left) and 29 in the bulb,16 on the right and13 on the left)Overall 50% of the plaques were located at the bulb, 31% in the common carotid artery and 19% in the internal carotid artery

Table -4–Intima media thickness

AGE	0.6-0.69MM	0.7-0.79MM	0.8-0.89MM	>0.9MM
40-49yrs	4	5	4	1
50-59yrs	1	6	1	5
60-69yrs	0	1	10	10
70-79yrs	0	0	1	2

In total 50 cases studied .the intima media thickness of bilateral common carotid arteries was measured .the intima media thickness of all cases in my study ranged between 0.7-1.2mm. Intima media thickness and relation with age .It is observed that IMT more than 0.8mm has high risk of CVA .in our study IMT more than 0.8mm was found in 35 pts(70%).out of which 20pts

were in age group of 60-69(57%),10 patients in the age group of 50-59(28%),and 5 patients in age group of 40-49 (14%)

Table :5 -Distribution of cases based on percentage of stenosis

Percentage of stenosis	Number of vessels (n=100)	Percentage (%)
< 50	92	92
50 – 69	7	7
≥ 70 but less than near occlusion	1	1
Near occlusion	0	0
Total occlusion	0	0

Out of 100 vessels examined, significant stenosis i.e., $\geq 50\%$ stenosis was seen in 8 (8%) vessels on colour flow imaging.

Out of the 8 vessels with significant stenosis 7 showed 50-69% stenosis, 1 showed $\geq 70\%$ stenosis .

Table :6 - distribution of cases based on peak systolic velocity ratio of ICA/CCA

PSV ratio of ICA/CCA	Number of Vessels (n=100)	Percentage (%)
< 2.0	88	88
2.0 – 4.0	7	7
> 4.0	1	1
Near occlusion	NA	-
Total occlusion	NA	-

NA: Not Applicable.

In our study based on the Peak systolic velocity ratio of ICA/CCA, 7 vessels showed significant stenosis i.e, ratio > 2

In 7 vessels the ratio was between 2-4, , in 1 vessels it was more than 4,

Table-7: Age wise distribution of cases with significant stenosis ($\geq 50\%$ stenosis)

Age group (Years)	Number of cases (n=8)	Percentage (%)
< 40	1	12.5
40 – 49	1	12.5
50 – 59	2	25
60 – 69	3	37.5
70 – 79	1	12.5
≥ 80	0	0.0
Side of Infarct		
Right	18	47.3
Left	13	34.2
Bilateral	7	18.4

Out of the 50 cases examined 8 patients had significant stenosis. Among them 37.5% were in 60 – 69 years age group. Out of the 38 cases with infarcts, 18 patients (47.3%) had infarcts on the right side, 13 patients (34.2%) had infarcts on the left side and 7 patients (18.2%) had bilateral infarcts. no infarcts in 7 patients.

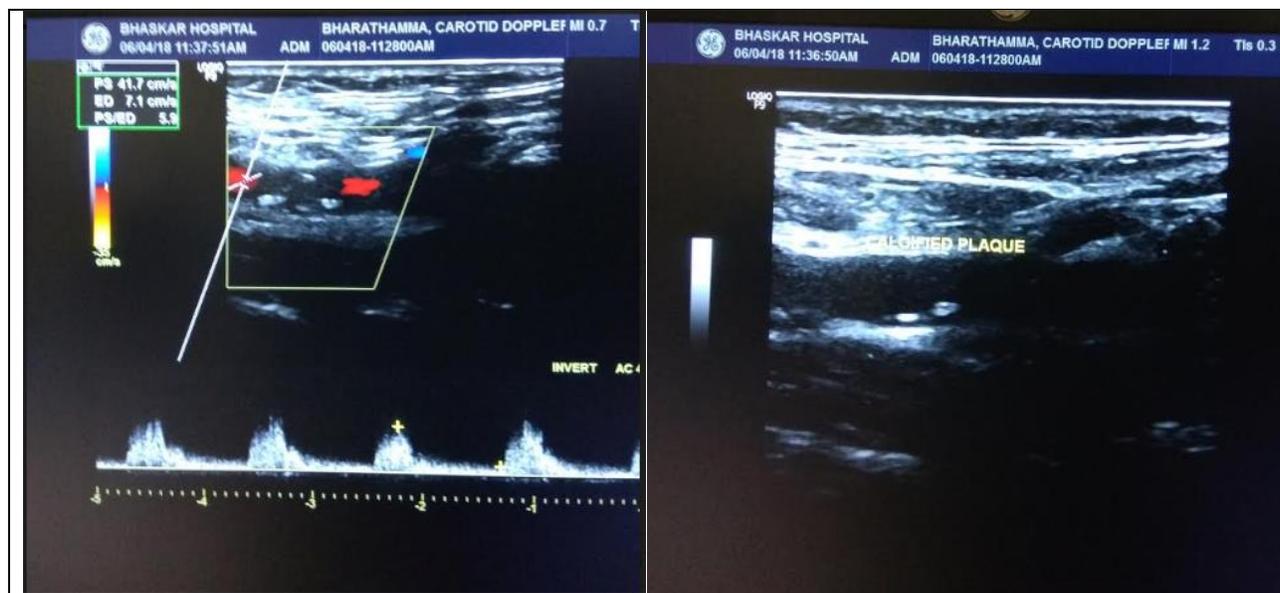
TABLE: 8 -TYPE OF INFARCT VS PERCENTAGE STENOSIS

Percentage of stenosis (%)	Cortical	Subcortical
<50	15	20
50-69	6	1
≥ 70 but less than near occlusion	1	0
Near occlusion	0	0
Total occlusion	0	0

Out of the 12 cases with significant stenosis ($\geq 50\%$), cases (75%) had a cortical infarct, two cases (16.6%) had a subcortical infarct.

FIGURE-1: IMAGES IN STUDY

<p>HETEROGENOUS PLAQUE WAS FOUND IN THE LEFT CCA BULB MEASURING 1.1X0.25CM</p>	<p>THE PLAQUE WAS CAUSING STENOSIS OF 46.6%</p>
<p>INFARCTS IN LEFT PARIETAL REGION (LEFT MCA TERRITORY INFART)</p>	<p>CT BRAIN SHOWED INFRACT IN THE RIGHT FRONTAL LOBE (RT ACA TERRITORY)</p>



DOPPLER: CALCIFIED PLAQUES IN LEFT CCA BULB ON COLOUR DOPPLER THERE IS NORMAL FLOW WITH NORMAL PSV.

DISCUSSION

Cerebrovascular disease is a major cause of death, behind only malignancy and cardiovascular diseases. American Statistics studies in the past have shown that there is an unusually high prevalence of atherosclerotic disease, especially cerebrovascular disease and cardiovascular disease in Indians in spite of low risk factors for atherosclerosis. [3]. The main role of carotid Doppler examination in the carotid artery disease is the detection of atheromatous plaques and the degree of stenosis. The accurate diagnosis of critical stenosis is important because these are the patients who carry increased risk of cerebral infarction.

The North American Symptomatic Carotid Endarterectomy Trial (NASCET) study, and the Asymptomatic Carotid Atherosclerosis study (ACAS) have demonstrated that the surgical treatment of endarterectomy should be reserved for those patients with carotid stenosis of more than 70%. Angiography which is the 'Gold Standard' has largely been replaced by Duplex ultrasonography in most diagnostic circumstances. Positive experience with carotid Duplex ultrasonography scanning unassisted by angiography in the setting of an impending surgical intervention has been embraced by a growing number of doctors [4]. The present study was done to evaluate extracranial carotid arterial system by Carotid Doppler in the population who presented with cerebrovascular insufficiency.

In the 50 cases studied, 30 patients were male (60%) and 20 patients were female (30%). Majority of the male patients were in the age group of 60 – 69 years (46.5%) and 50% of female patients were in the age group of 60 – 69. In our study 56% of patients were above the age of 60 years. These findings correlated well with the ACAS study in which 50% of the patients

were above the age group of 60 years. Prevalence of atherosclerosis increases with age [5]. Wolf et al [6] reported a mean age of 65.4 years in men and 66.1 years in females. In our study out of 75 cases, 30 were males and 20 were females with a male: female ratio of 3 :2. This is comparable to the study of Paivansalo M [7], Leinonen S, Turunen J et al [8], where male to female ratio was 2:1. Overall men are more prone to atherosclerosis than women.

It was observed that with increasing age IMT was more, and increase in IMT is predictor for atherosclerosis. Intima media thickness is considered as a surrogate marker for atherosclerotic disease not only in the cerebrovascular system, but in the whole arterial system. It is believed that thickening of the intima media thickness complex greater than 0.8 mm is abnormal and may represent the earliest changes of atherosclerotic disease. The results showed that mean intima media thickness in our study was slightly greater than that found by Ratnakar Sahoo et al (9), where it was 0.78 mm (range 0.5-1.5 mm) in patient group and 0.594 mm (range 0.4-0.9 mm) in controls.

In our study of 50 patients, atheromatous plaque was found bilaterally in 10 patients (20%), on the right side in 20 patients (40%) and on the left side in 18 patients (36%). No plaques were observed in 7 patients (14%). Of the 58 plaques, 18 were located in common carotid artery (10 on the right and 8 on the left), 11 in internal carotid artery (7 on the right and 4 on the left) and 29 at the carotid bulb, near the bifurcation (16 on the right and 13 on the left). Overall 50% of the plaques were located at the bulb, near the bifurcation, 31% in the common carotid artery and 19% in the internal carotid artery. This finding is similar to that observed by Rajagopal et al (2000). [10]

A total of 58 plaques were observed in the 100 vessels that were examined. Out of the 58 plaques, 20 (34.4%) were calcified, 10 (17.2%) were of low echogenicity, 28 (48.2%) were moderately echogenic. SK SETHI et al [11] observed in their study that 53% of plaques were echogenic, 36% were calcified and 11% were hypoechoic. Bluth EL, McVay LV, Meritt RB et al [12] and Reilly M, Lusby RJ, Hughes L et al suggested that the risk of embolization or rapid progression depends upon plaque composition especially if it was heterogeneous, diffuse or focal. Moneto GL [13], Taylor DC, Nicholis L et al and Henry ML [14], Kongable GL, Sevilla EA et al (1988) and Carroll B [78] (1988) have stated that no correlation exists between the presence of calcification and symptomatology but Brown PB, Zwiebel WJ, Call CK et al [15] have emphasized that the plaque calcification may have prognostic value and may be useful for selection of patients for medical or surgical therapy.

Out of 100 vessels examined, significant stenosis i.e., $\geq 50\%$ stenosis was seen in 8 (8%) vessels on colour flow imaging. Out of the 8 vessels, with significant stenosis ($\geq 50\%$), 7 showed 50-69% stenosis, 1 showed $\geq 70\%$ but less than near occlusion. Erickson et al and Steinke et al (14) have calculated the percentage of stenosis by directly measuring the color flow lumen at the site of maximum stenosis and then comparing it with total lumen of vessel itself. Robinson et al (1992) found that color imaging is helpful as it improves visualization of the lumen and consequently allows for more accurate placement of the cursor and correction of the Doppler angle. [16]

In our study, based on the Peak systolic velocity ratio of ICA/CCA, 11 vessels showed significant stenosis i.e., ratio > 2. In 7 vessels the ratio was between 2-4, in one vessel it was more than 4. Based on distribution of cases (n=50) 12 with significant stenosis, Among them 37.5% were in 60 – 69 years age group.

Out of the 38 cases with infarcts, 18 patients (47.3%) had infarcts on the right side, 13 patients (34.2%) had infarcts on the left side and 7 patients (18.4%) had bilateral infarcts. Out of the 12 cases with significant stenosis ($\geq 50\%$). All patients having stroke, where carotid artery disease is the cause had carotid artery disease at expected side or were having bilateral involvement that is all the patients having right sided stroke clinically, had left sided infarct on CT and left extra cranial carotid artery disease and vice versa or had bilateral extra cranial carotid artery disease.

These findings are similar to the observations of **JS Jeng et al**[17] who in their study “Extracranial carotid atherosclerosis and vascular risk factors in different types of ischemic stroke in Taiwan” observed that 32% of the Cortical infarction subgroup, 3% of the Subcortical infarction subgroup possessed severe carotid stenosis ($\geq 50\%$ stenosis or occlusion). The extent and severity of extracranial carotid artery atherosclerosis were more prominent in patients with Cortical Infarction than in patients with other types of ischemic stroke. In patients with Cortical Infarction, severe carotid stenosis is not uncommon; in patients with Subcortical infarction, however, the frequency of carotid stenosis is quite low.

According to the study conducted by SK SETHI et al (2005)[11] all patients with >40% stenosis had a cortical infarct, none of patients with >40% stenosis had a subcortical infarct. All patients with subcortical infarcts had either normal extracranial carotids or had <40% stenosis. These subcortical infarcts were probably caused by obstruction of deep penetrating vessels by lipohyalinosis and microatheromatous producing a distal hemodynamic compromise and lacunae.

CONCLUSIONS

Patients in this study, who were detected with stroke had atheromatous changes in carotid with partial /complete occlusion. The site most commonly involved in the extracranial carotid system was carotid bifurcation. And carotid bulb. In the present study majority of plaques are heterogenous (moderate echogenicity). Plaque characterisation was better done on B-mode imaging

In the present study colour Doppler imaging was superior to B-mode imaging in detecting high grade stenosis and in differentiating near total occlusion and total occlusion. Doppler sonography provides a rapid, non-invasive, relatively inexpensive and accurate means of diagnosing carotid stenosis. The present study highlights the importance of Doppler sonography in this stroke prevention effort through surveillance for atherosclerosis that predisposes a person to cerebral ischemia.

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