ORIGINAL RESEARCH PAPER

Radiology

KEY WORDS: Colour Doppler, stroke, carotid artery.

# COLOUR DOPPLER IMAGING IN PATIENTS OF STROKE FOR EVALUATION OF CAROTID ARTERIES

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ABSTRACT

**INTRODUCTION**: Atherosclerotic cerebral vascular disease is a life threatening and debilitating neurological disease. Studies have shown that there is a close Relationship between carotid artery stenosis and ischemic cerebral vascular Disease.
**OBJECTIVES**: This study is done to assess carotid arteries with the help of color Doppler and B mode imaging and to correlate cerebrovascular accidents with extra cranial carotid artery status.
**METHODS**: Study was carried out on 50 patients presenting with complaints of stroke and reffered to the department of Radio-diagnosis, MGM Hospital, Kamothe, Navi Mumbai during October 2015 to November 2017. The data gathered from color Doppler examination consisted of peak systolic velocity of CCA and ICA, velocity ratios between ICA and CCA and plaque characteristics as seen on the real time image.
**RESULTS**: The highest incidence of stroke was found in male population in the age group of 50-59 years. Various risk factors included hypertension, diabetes mellitus, smoking, and family history. Out of 50 patients, 14 patients showed significant stenosis (>60%). Atherosclerotic plaques were seen in 25 patients (50%).
**CONCLUSION**: Color Doppler examination is an economic, safe, reproducible and less time consuming method of demonstrating the cause of cerebrovascular insufficiency in the extra cranial carotid artery system and will guide in instituting treatment modalities.

## INTRODUCTION

Atherosclerotic cerebral vascular disease is a life threatening and debilitating neurological disease. Following cancer and heart disease, it is the third leading cause of death in the world. The stroke syndrome consists of rapid development of a focal neurologic deficit that is usually localized to an area of brain supplied by a specific artery. Treatment of stroke depends on reaching the most accurate diagnosis. Several modalities of investigation are available to determine carotid artery status. Non-invasive modalities are popular. The value of safe, noninvasive and low cost screening test is therefore great. Doppler ultrasound study of carotid system is one such modality. Duplex sonography, combining high resolution imaging and Doppler spectrum analysis has proved to be popular, non-invasive, accurate and cost effective means of assessing carotid artery disease.

## AIMS AND OBJECTIVES

1. To assess carotid arteries with the help of Color Doppler and B-mode imaging in carotid artery disease.
2. To correlate cerebrovascular accidents with extra-cranial carotid artery status.

## MATERIALS AND METHODS

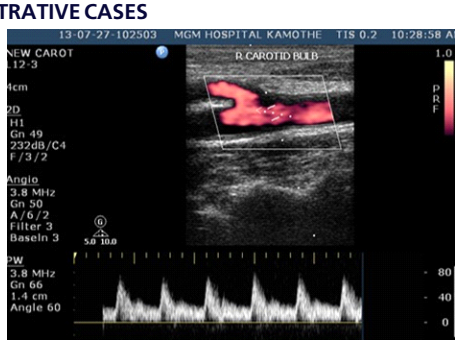
This study was carried out in patients who had symptoms and signs of strokes, or transient ischemic attacks at MGM Medical College, Navi Mumbai from the period of October 2015 to November 2017. The study was carried out on 50 patients. Among the 50 patients studied 41 patients (82%) were males and 9 (18%) were females. Color Doppler examination of the carotid arteries was done using Phillips color Doppler- HD-11 ultrasound machine with 7-12 MHz linear array electronic transducer. The data gathered from the color Doppler examination consisted of peak systolic velocity of common carotid artery, peak systolic velocity of internal carotid artery, velocity ratios between internal carotid artery and common carotid artery and plaque characteristics as seen on the real time image.

## OBSERVATION AND RESULTS

The highest number of stroke patients in this study were found in the age group of 50-59 years that is 14 patients (28%). 11 patients (22%) were of the age group of 60-69 years. 10 patients (20%) were in the age group of 40-49 years. 9 patients (18%) were in the age group of 70-79 years. 6 patients (12%) were in the age group of greater than 80 years. 20 patients had right sided stroke.18 patients had left sided stroke. Bilateral involvement was seen in 2 patients and 10 patients had transient ischemic attacks. Out of 50 patients, 21 patients had hypertension, out of which 7 patients had significant stenosis, 7 patients had diabetes mellitus with 3 patients showing significant stenosis. 22 patients had history of smoking with 8 patients showing significant stenosis. 6 patients had family history of stroke and 4 of them showed significant stenosis. No patient in the study had history of ischemic heart disease. Out of the 14 patients with significant stenosis (>60% stenosis) the age distribution was maximum in the age group of 50-59 years that is 6 patients. Next was the age group of 70-79 years with 3 patients. 2 patients each were in the age group of 60-69 years and >80 years. 1 patient was in the age group of 40-49 years.

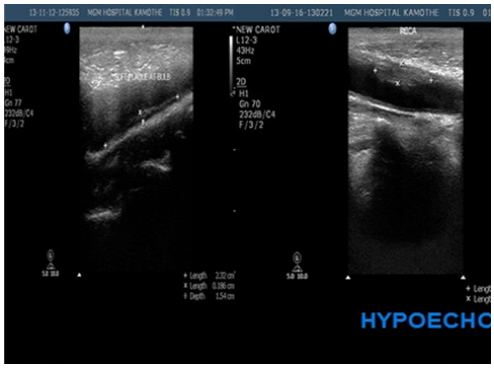
Of the 14 patients with significant stenosis, 6 patients (40%) showed bilateral involvement. 5 patients (36%) had right sided involvement. 3 patients (21%) had left sided involvement. With the criteria of internal carotid artery/common carotid artery ratio, on the right side 9 patients had 60-79% block, 1 patient had 80-99% block and 1 had total block. On the left side, 5 patients had 60-79% stenosis, 1 had 80-99% block and 3 patients had total block. Atherosclerotic changes in the form of atheromatous plaques are found to be the main cause of obstruction. Out of the 25 patients having plaque in the extra-cranial carotid system, 9 (36%) patients had bilateral involvement. 8 patients (32%) had plaque on the right side and 8 patients (32%) had plaques on the left side. Internal carotid artery was the commonest site of involvement with 9 patients showing plaques in the right internal carotid artery and 11 patients in the left internal carotid artery. 4 patients showed plaques in the right common carotid and 3 patients on the left. Carotid bulb plaque were seen in the right side in 4 patients and left side in 3 patients. In the right side extra-cranial carotid arterial system, 9 were calcified plaques. 5 were homogenous plaques and 3 were non homogenous plaques. In the left side, 5 were calcified plaques and 6 were non homogenous plaques.

## ILLUSTRATIVE CASES

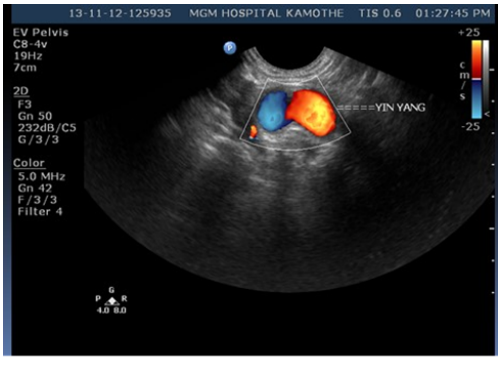


**NORMAL RT CAROTID BULB FLOW AND WAVEFORM**


**INCREASED INTIMA MEDIA THICKNESS**




**HYPOECHOIC PLAQUE**




**PSEUDO ANEURYSM WITH YIN-YANG SIGN**

## DISCUSSION

Angiography is gold standard but invasive and expensive and involves significant risk to the patients. Sonography is unique among vascular imaging procedures in that it can assess plaque composition. Sonographically detected plaque characteristics may have prognostic value and may be useful for selection of medical and surgical therapy. The present study was done to evaluate the extra-cranial carotid arterial system in the population who presented with stroke.

Palomaki H et. al studied the risk factors for cervical atherosclerosis in patients with ischemic stroke and transient ischemic attack and found that incidence of stroke increases after 60 years of age 10. Iemolo F et al. in his study showed that only 2.5% of stroke victims were females [1]. In this study 82% of the patients (41/50) were males and 16 only 18% were females (9/50). The risk factors that cause plaque formation and stroke were evaluated. In this study out 5 of the 50 patients 21 patients had variable degree of hypertension out of which 7 had significant stenosis. Carlene Lawes et al in their studies had studied 188000 patients with hypertension out of which 6800 had stroke events [2]. 22 of the patients in our study had history of smoking . Of them 8 had significant stenosis. Iadecola et al had proved that control of blood pressure leads to a substantially lower risk of stroke. Toshifumi Mannami et al confirmed a positive relationship between smoking and risk of stroke. They estimated that 22% of stroke was attributable to smoking [3]. In this study 7- 8 patients had diabetes mellitus of which 3 had significant stenosis. Diabetes mellitus is another risk factor for atherosclerosis. Lindberg Pertu and Roine Risto in their study had observed that two thirds of all ischemic stroke types on admission had diabetes mellitus [2] . In this study family history of stroke was present in 6 patients of which 4 had significant stenosis. Schulz U. G. R, Flossmann E and Rothwell studied family history of stroke and found that 23% of stroke patients had positive family history [4]. The patients in our study were ruled out from cardiac problem, which will interfere in the velocity profiles of the carotid system. A diminished cardiac output will reduce both systolic and diastolic velocities. In the ultrasound literature different authors say that one or another of the 3 major Doppler parameters that is peak systolic velocity, end diastolic velocity or systolic velocity ratio is the most accurate predictor of clinically significant ICA stenosis. Initially peak systolic velocities were defined for predicting the amount of stenosis, which are not very well defined due to physiological variability and obstructive lesions. Because a ratio compensates for patient to patient physiological variability and also compensate for instrument variability peak systolic velocity ratio has been considered best for assessing stenosis as proved by Zwiebel William J in his studies. North American Symptomatic Carotid Endarterectomy Trial (NASCET) and European Carotid Endarterectomy Trial clearly demonstrated that the long term benefits of endarterectomy were significantly greater than medical treatment in patients with 60% or 70% internal carotid artery stenosis, whether symptomatic or asymptomatic. Second, the endarterectomy trials established 60-70% diameter reduction as clinically significant levels of ICA stenosis [5]. Arbeille Ph defined a peak systolic velocity ratio of greater than 1.8 as an indicator of 60% or greater and a ratio of 3.7 as an indicator of more than 80% diameter stenosis [6]. In this study the peak systolic velocity ratio of ICA / CCA is taken to define the percentage of significant stenosis. Out of 14 patients with significant stenosis (>60%), 5 (36%) patients had significant block on the right side, 3 (28%) had significant stenosis on the left side and bilateral significant block in 6 (36%) patients. On the right side, 9 patients had 60-79% stenosis, one patient had 80-99% stenosis and one had total block. On the left side 5 patients had 60-79% stenosis, one had 80-99% stenosis and 3 patients had total block. The commonest cause for obstruction is due to the atheromatous plaque. Schulte Altedorneburg G et al found steno occlusive carotid lesion in 64% of the patients studied [7]. He also confirmed his findings by post mortem studies. In our study 25 (50%) patients had plaque in the carotid system. 8 patients had plaque on the right side, 8 patients had plaque on the left side and 9 patients had bilateral involvement. Zwiebel W J, found that the carotid bifurcation was commonly involved by the atherosclerotic plaque followed by the origin of carotid arteries [5] . In our study internal carotid artery was found to be the commonest site affected by the plaque. In the right internal carotid artery plaques were found in 9 patients and in 11 patients on the left. Plaques in carotid bulb were seen on the right side in 4 patients and on the left side in 3 . Plaques in the common carotid artery were also seen on the right side in 4 patients and 3 on the left side. Aburahma Ali F, Wulu John T & Crotty Brad had confirmed that soft plaques and nonhomogeneous plaques are more positively correlated with symptoms than with any degree of stenosis and were the cause of adverse neurological events[8]. In this study 5 patients had homogenous plaques on the right side, 3 had non homogeneous plaques and 9 patients were found to have calcified plaques. On the left side 6 patients had homogenous plaques, 6 had non homogenous plaques and 5 had calcified plaques. No histopathological correlation was done in our study because surgery was not done in any of the above patients. These patients were managed conservatively.

## SUMMARY

The highest incidence of stroke was found in the age group of 50-59 years with male population commonly affected. The various risk factors included hypertension, diabetes mellitus, smoking and

family history. Out of 50 patients 14 patients showed significant stenosis (>60%stenosis) as determined by the real time imaging, the peak systolic velocity ratio between the internal carotid artery and common carotid artery (ICA / CCA), spectral broadening and the color flow pattern. Atherosclerotic plaques were seen in 25 (50%) patients.

## CONCLUSION:

Our study concludes that Color Doppler examination is noninvasive, economic, safe, reproducible and less time consuming method of demonstrating the cause of cerebrovascular insufficiency in the extra cranial carotid artery system and will guide in instituting treatment modalities. The duplex method has been recommended as the most effective means, because it is able to detect both morphological and hemodynamically changes. The digital subtraction angiography is the gold standard in evaluating internal carotid arteries, it is an invasive procedure.

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