



## Radiodiagnosis

## ROLE OF COLOUR DOPPLER SONOGRAPHY IN EVALUATION OF EXTRA CRANIAL CAROTID VESSELS IN PATIENTS OF STROKE

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**ABSTRACT**

**Introduction:** Colour doppler is indispensable in imaging carotid vessel pathologies along with gray scale imaging in patients of stroke.

**Aims:** This study concerns with- To evaluate demographic variables of patients who are manifest stroke and correlate with carotid vessel pathologies. Evaluate the pathological variations of extra-cerebral portion of carotid vasculature in patients with attributable neurological insufficiency. Assess the efficacy of color Doppler parameters in prediction of severity of stroke.

**Settings and Design:** A Prospective Hospital based study of 100 cases of stroke and transient ischaemic attack presented to our Department.

**Methods and Material:** Study Included 100 patients of all age groups having clinical symptomatology pertaining of stroke and transient ischaemic attack over the period of two years. Written informed consent was taken. All patients were examined with grey scale and Doppler ultrasound with proper technique via Philips HD11X ultrasound machine.

**Results:** Among 100 patients studied 60 (60%) patients were males and 40 (40%) were females. The highest number of stroke patients in our study was found to be of age group 31 to 71 years which were 76%. 71(71%) patients had carotid arterial system plaque while 29(29%) patients in our study design had no plaque. Among the patients positive for carotid arterial system plaque (N=71) hypertension (59.15%) was the most common risk factor in our study followed by diabetes mellitus (40.84). 81 patients had positive findings on CT brain findings while 19 patients were normal. Amongst 81 patients who were positive on CT brain 58 (72%) patients had significantly increased Intima Media thickness (i.e. more than 0.8mm). Amongst total of 71 patients who had positive carotid arterial system plaque 37 patients had carotid arterial stenosis less than 50% and PSV ratio of less than 2, 16 patients had stenosis in the range of 50 to 69% and PSV ratio between 2 to 4, 15 patients had more than 70%, PSV ratio more than 4.0. 3 patients had luminal occlusion of carotids.

**Conclusions:** Study highlights the various risk factors associated with the stroke. Careful evaluation of carotid arteries with Doppler sonography leads to the diagnosis of various morphological and hemodynamic alterations which might help patient with timely intervention. Doppler helps in not only diagnosing but also in prognosis of carotid disease in symptomatic as well as asymptomatic high risk patients for cerebral ischemia.

**KEYWORDS :** IMT- Intima-Media Thickness, PSV- Peak systolic velocity.

**Introduction:**

A stroke is defined by the World Health Organization (WHO) as a syndrome of "rapidly developing clinical symptoms and/or signs of focal (or at times global) disturbance of cerebral function lasting more than 24 hours (unless interrupted by surgery or death), with no apparent cause other than of vascular origin."<sup>1</sup> Stroke is the major burden of morbidity and mortality in our society. An estimated 80% of strokes are thromboembolic in origin, often with carotid plaque as embolic source.<sup>2</sup> Carotid arteries are major vascular blood supplier of brain. Lesions of the extra cranial carotid arteries, particularly the internal carotid artery near the bifurcation, are implicated in majority of cases of cerebrovascular disorders.<sup>3</sup> The carotid arteries lends themselves to study by high resolution ultrasound devices because it is superficial in location. Appropriate detection and quantification of carotid artery disease has a decisive impact on the patient prognosis. Being easily available, Non-invasive, reproducible Ultrasound examination is first choice of carotid evaluation. We emphasize the importance of extra-cranial carotid Doppler ultrasound via various Doppler parameters in diagnosis and prognosis of carotid artery disease. We also highlight various demographic risk factors in patients of stroke and their association with carotid artery morphology and hemodynamic alteration via carotid ultrasound.

**Aims and Objectives:** This study concerns with- To evaluate demographic variables of patients who are manifest stroke. (Diabetes Mellitus, Hyperlipidemia, Hypertension) and correlate with carotid vessel pathologies. Evaluate the pathological variations of extra-cerebral portion of carotid vasculature in patients with attributable neurological symptoms and physical signs. Assess the efficacy of color Doppler parameters in prediction of severity of stroke. To assess the utility of peak systolic velocity and peak systolic velocity ration of ICA/CCA in diagnosing carotid artery stenosis. To evaluate spectral pattern of duplex in hemodynamically significant carotid artery

stenosis.

**Subjects and Methods:**

A Prospective Hospital based study of 100 cases of stroke and transient ischaemic attack presented to the Department of Radiodiagnosis over the period of two years in our tertiary care centre. The study included both male and female patients of all age groups presented with complaints and clinical symptomatology attributable to stroke or Transient ischemic attack referred for CT brain. All the co morbid, comatose and uncooperative patients were excluded from the study. Written informed consent of all study individuals taken. Detailed clinical history, physical examination, laboratory investigation data entered into the pre formed case proforma. Using the Philips HD11x Linear Transducer with proper ultrasound scanning technique, all the Doppler parameters were evaluated and data recorded. Collected data was analyzed and presented in the form of tables and graphs.

**Results:**

Age and Sex distribution of the subjects is shown in table 1 and 2, Graph 1 and 2. Among 100 patients studied 60 (60%) patients were males and 40 (40%) were females. The highest number of stroke patients in our study was found to be of age group 31 to 71 years which were 76%. (Table No.1)

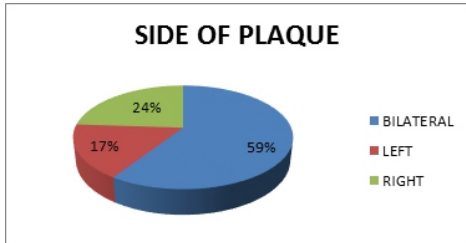
**Tab no.1 AGE AND SEX DISTRIBUTION**

AGE	MALE	FEMALE	TOTAL
21 - <31 YRS	0	1	1
31 - <41 YRS	5	4	9
41 - <51 YRS	12	9	21
51 - <61 YRS	18	7	25
61 - <71 YRS	18	12	30
71 - <81 YRS	5	4	9

81 - <91 YRS	2	3	5
<b>TOTAL</b>	<b>60</b>	<b>40</b>	<b>100</b>

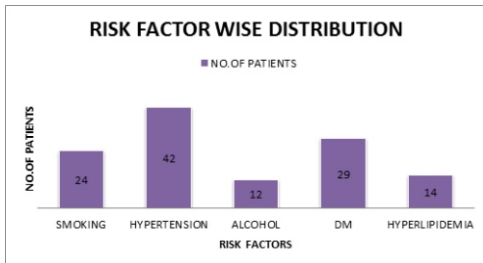
CT Brain showed maximum number of patients having Acute infarct in right MCA territory 24% (n=24) followed by lacunar infarct 21% (n=21) and Acute Left MCA territory infarcts 20% (20). Out of 100 patients studied 19(19%) patients had normal findings on CT brain. 71 patients showed carotid artery plaques. Out of 71, 42 (59%) patients had bilateral, 17(24%) had right and 12(17%) patients had left sided carotid artery system plaque. 29 patients did not show any plaque. (Graph no.1)

**Graph NO. 1: SIDE OF PLAQUE INVOLVEMENT**



Out of 71 patients, maximum patients showed plaque which was in the CCA extending into the ICA (n=26, 36%) followed by the plaque involving isolated ICA (n=21, 29%) and Carotid Bulb (n=16, 22%).

**GRAPH NO.2: RISK FACTOR WISE DISTRIBUTION**

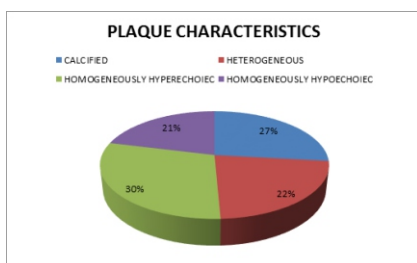


Among the patients positive for carotid arterial system plaque(N=71) hypertension (59.15%) was the most common risk factor in our study followed by diabetes mellitus (40.84%), smoking (33.80%), hyperlipidemia (19.71%) and alcohol (16.90%). (Graph no. 2) 21(30%) patients showed homogeneously hyperechoic plaque, 15 (21%) had

FINDINGS	NO.OF PATIENTS HAVING POSITIVE FINDINGS(N)AMONGST TOTAL NO.OF (100)PATIENTS	NO.OF PATIENTS HAVING IMT MORE THAN 0.8MM(AMONGST "N")	PERCENTAGE
CT BRAIN FINDINGS	81	58	71.60%
HTN	56	39	69.64%
ALCOHOLISM	14	13	92.85%
DM	39	25	64.10%
SMOKING	24	19	79.16%

homogeneously hypoechoic while 19 (27%) patients had plaques which were calcified and 16(22%) had heterogeneous.(Graph No.3)

**Graph No.3: PLAQUE CHARACTERISTICS ON ULTRASOUND**



Amongst the CT Brain positive findings patients (81) in our study, 58 (72%) patients had significantly increased carotid intima media thickness (>0.8mm) on grey scan ultrasound. Similarly it was 69% amongst hypertensive patients, 93% amongst alcoholic patients, 64% in Diabetics and 79% amongst the study patients who had smoking history positive. (Table No.2)

**TAB.NO. 2: RELATION OF RISK FACTORS AND SIGNIFICANT IMT THICKENING (>0.8mm)**

CT BRAIN FINDINGS	81	58	71.60%
HTN	56	39	69.64%
ALCOHOLISM	14	13	92.85%
DM	39	25	64.10%
SMOKING	24	19	79.16%

**TAB NO. 3: RATIO OF PEAK SYSTOLIC VELOCITY OF ICA TO CCA**

PSV RATIO	PERCENTAGE OF STENOSIS	NO.OF PATIENTS (AMONGST THE CAROTID PLAQUE POSITIVE PATIENTS)
<2	<50%	37
2 TO 4	50 TO 69%	16
>4	>70%	15
TOTAL BLOCK	OCCLUSION	3
<b>TOTAL</b>		<b>71</b>

**GRAPH NO.4: RATIO OF PEAK SYSTOLIC VELOCITY OF ICA TO CCA**

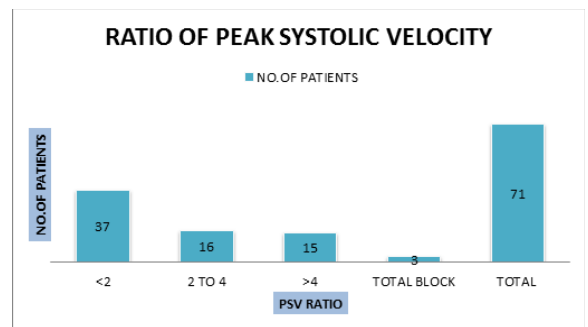


Table No. 3 and graph no.4 shows relation of peak systolic velocity ratio of ICA to CCA and percentage of stenosis. We found that PSV ratio of ICA to CCA was less than 2 for stenosis of carotid arterial system less than 50%. The patients in this group were 37(52.11%) out of 71(total no. Of patients having plaque), which is the largest group amongst studied patients. Another group having PSV ratio between 2 and 4 had the percentage of stenosis between 50 to 69% and number of patients in this group were 16(22.53%) out of 71. The patients who had PSV ratio more than 4, had percentage of stenosis more than 70% were 15(21.12%). 3(4.22%)/71 patients had complete occlusion of ICA in which the PSV ratio could not be evaluated.

**Discussion:**

Two randomized clinical trials, the North American Symptomatic Carotid Endarterectomy Trial (NASCET) and European Carotid Surgery Trail (ECST) have clearly shown the benefit of endarterectomy in symptomatic patients with greater than 70% carotid stenosis (C.RANKE 1999). In our study Male and female ratio was 1.5: 1, comparable to study Paivansolo.M.Leinines, and Trunen. J et al (1996) who quoted male and female ratio as 2:1 and also highest incidence of carotid artery disease were among patients between 30 to 60 years. Andreloi TE and et al. in 2000 concluded that modifiable risk factors such as HT, hypercholesterolemia, smoking, glucose intolerance, obesity and sedentary life style as well contribute to the development of atherosclerosis4. 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 disease5. The study results of our study regarding significant increase in Intima media thickness are comparable with study done by R Salonen in 19915 and Sacco et al., 20136 who stated that smoking, HT, hyperlipidemia, significantly increases the carotid IMT. Most of the plaques (80%) in transient ischemic attack patients were smooth

surfaced while in stroke patients, irregular surfaced and ulcerated plaques together accounted for 43% of plaques comparable with study by Ulf Scheminke and Tillian Motsch et al (2000)<sup>7</sup> In our study we observed that 37 out of 71 (having carotid plaque) patients had less than 50% stenosis. 16 patients had between 50-69% stenosis. 15 patients had stenosis more than 70%. 3 patients had complete carotid occlusion. Out of total 19 TIA patients 9 patients had stenosis less than 50% and only one (5%) patient had significant (>50%) stenosis while 9 patients had no any carotid luminal stenosis. In out of 81 stroke patients who were positive on CT brain findings 33 (41%) patients showed significant (more than 50%) luminal stenosis on ultrasound. Recognising that duplex criteria from different centres differ for the threshold levels of angiographic stenosis determined by ACAS and NASCET<sup>9</sup>, a panel of authorities from a variety of medical specialities assembled to review carotid ultrasound literature in 2003<sup>8</sup>. Our study results are comparable to the recommendations given by this committee. We found that 16 patients having percentage of stenosis more than 70% had PSV more than 212cm/s and 16 patients having stenosis between 50-69% had PSV varying between 113 to 210cm/s comparable with similar study done by Carpenter et al, 1996 who stated that for 70% stenosis the increase in PSV was about 210 cm/s. PSV could not be evaluated in 3 patients having total carotid occlusion. According to Erickson S.J, Middleton W.D, Mewissen. M.W. et al (1988) the diagnosis of occlusion of ICA is based on following observation:

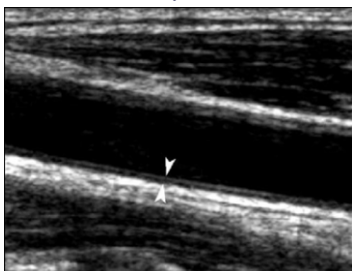
1. Absence of arterial pulsations.
2. Lumen filled with echogenic material.
3. Absence of Doppler flow signals.
4. Dampened high resistance with ipsilateral CCA or proximal ICA.

In our study we found 3 patients with occlusion of ICA satisfying all the above mentioned criteria.

Conclusion: Hence we conclude that the introduction of Doppler imaging has dramatically changed the diagnostic evaluation of suspected carotid disease. Doppler sonography provides a rapid, non-invasive, relatively inexpensive, safe, reproducible and accurate means of evaluating the extra cranial carotid artery system. Physicians have long sought methods for identifying stroke-prone patients, with the hope that timely intervention might avert stroke and its accompanying disability. The present study highlights the importance of Doppler sonography evaluation of Extra-cranial carotid arterial system in patients with cerebral ischemic stroke. In addition carotid sonography can also be used to assess the prognosis in both symptomatic and asymptomatic patients presenting with any of the risk factors for cerebral ischemic stroke.

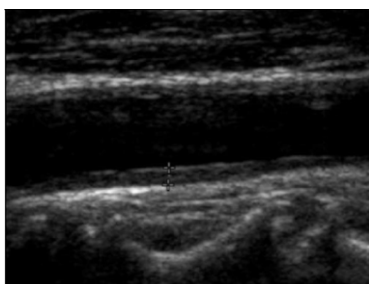
**Images:**

**1. Normal Ultrasound Anatomy of carotid arterial system**

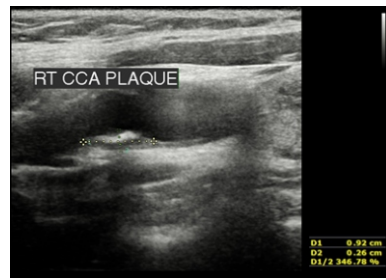


**Normal Intima Media Thickness Common Carotid artery [0.6-0.8mm]**

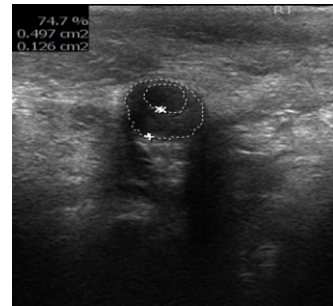
**2. Increased IMT of CCA [1.56mm]**



**3. Calcified Plaque**



**4. Plaque causing significant Carotid arterial Stenosis (75%)**



**5. Acute Infarct in left MCA territory (MCA-Middle Cerebral Artery)**



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