International Journal of Radiology Research
www.radiologyjournal.in
E-ISSN: 2663-4562, P-ISSN: 2663-4554
Received: 28-07-2024; Accepted: 27-08-2024; Published: 11-09-2024
Volume 6, Issue 2, 2024, Page No. 32-35

Evaluation of carotid arterial system in stroke patients using colour doppler sonography in a tertiary care institute

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Abstract
Introduction: Stroke ranks among the world's major causes of mortality and disability, often linked to carotid artery atherosclerosis. Non-invasive imaging techniques such as colour Doppler sonography provide valuable insights into the carotid arterial system.
Objectives: To assess the carotid artery system in stroke patients with colour Doppler sonography, with an emphasis on carotid stenosis, plaque morphology, and intima-media thickness (IMT).
Methods: This observational research included 50 stroke patients from a tertiary care hospital. Colour Doppler sonography was performed to measure IMT, Assess the degree of carotid stenosis and categorise the structure of the plaque.
Results: Majority of carotid arteries had <50% stenosis. Older age linked to greater stenosis and IMT. Color Doppler imaging is effective for screening carotid artery disease.
Conclusion: Colour Doppler sonography is an effective tool for non-invasive evaluation of carotid arterial system, aiding in early detection and management of carotid artery disease.

Keywords: Carotid arterial system, stroke, colour doppler sonography, carotid stenosis, plaque morphology

Introduction
Stroke represents a major global health issue, resulting in considerable illness and death. Ischemic strokes make up about 80–85% of all strokes, and carotid artery stenosis is an important contributing risk factor [1]. Narrowing of the carotid arteries, primarily because of atherosclerosis, can lead to diminished cerebral blood flow and increase likelihood of thromboembolic events [1]. Accurate and prompt assessment of the carotid arteries is crucial for effective management. And prevention of stroke. Colour Doppler sonography has emerged as a reliable, non-invasive imaging technique for assessing carotid artery stenosis. It offers real-time visualization of blood flow and vessel wall abnormalities, making it a valuable tool in the clinical evaluation of stroke patients [3]. This study aims to assess the carotid arterial system using colour Doppler sonography in stroke patients admitted to a tertiary care hospital.

Aims and objectives
The objective of this study is to evaluate carotid arterial system using colour Doppler sonography in stroke patients. The specific objectives include:
- Evaluating the prevalence of carotid artery stenosis in patients with stroke.
- Analyzing the affiliation between carotid artery stenosis and patient demographics such as age and gender.
- Evaluating the efficacy of colour Doppler sonography in detecting carotid artery abnormalities.

Review of literature
Carotid artery disease has been widely studied due to its significant role in cerebrovascular events. Carotid sonography has been demonstrated as an effective tool in detecting stenosis and assessing stroke risk [4]. Research has demonstrated that the existence of plaques in the carotid arteries, particularly those causing significant luminal narrowing, has been linked to a higher risk of stroke [5]. Development of colour Doppler sonography has enhanced the ability to evaluate both the structural and hemodynamic aspects of the carotid arteries. It allows for the measurement of intima-media thickness (IMT) and the detection of turbulent flow, both of which are indicators of atherosclerotic disease [6]. Previous research has highlighted the utility of this imaging modality in routine stroke care, emphasizing its role in both diagnosis and follow-up [7].

Material and Methods
Study Design
This cross-sectional investigation was carried out at the Department of Radiodiagnosis, IIMS&R, Lucknow. The institutional review board granted ethical approval.

Study Population
The study involved the enrolment of a total of [50] patients who had been diagnosed with stroke. The inclusion criteria was patients with confirmed ischemic stroke, while exclusion criteria included patients with a history of carotid surgery or incomplete medical records.

Data Collection
All patients underwent a detailed clinical examination followed by colour Doppler sonography of the carotid arteries. The sonographic evaluation was performed using [Aloka Hitachi F 31 Ultrasound and Doppler machine], and images were analyzed for the presence of stenosis, plaque morphology, and IMT.

Statistical Analysis
[SPSS version 24.0 (IBM Corp, Armonk, NY, USA)] was used to analyse the data. The sonographic results and patient

data were compiled using descriptive statistics. Using logistic regression analysis and chi-square testing, the prevalence of carotid artery stenosis was determined along with its correlation with demographic characteristics.

Observations and Results

- **Demographics:** 50 patients (72% male, 28% female), mainly 60-69 years.
- **Plaque Detection:** 71 out of 100 arteries had plaques.
  - **Types:** 39.43% hypoechoic, 21.13% hyperechoic, 39.43% calcified.
  - **Surface:** 15.49% irregular, 84.5% smooth.
- **Plaque Morphology**: Irregular plaques were mostly calcified (72.72%). Smooth plaques: 43.33% homogeneously hypoechoic, 33.33% calcified.
- **Stenosis Severity:** 73.2% <50%, 12.7% 50-59%, 5.6% 60-69%. More prevalent on the left (52.1%). Males more likely to have <50% stenosis ($p < 0.01$).
- **Hemodynamics:** Higher stenosis associated with increased ICA velocities.
- **IMT:** 48% had IMT >0.80mm; 29.16% under 60 years, 70.84% over 60 years.

Statistical analysis

We found statistically significant association among carotid artery stenosis and male gender ($p < 0.05$). Additionally, age was found to be a significant predictor of stenosis severity ($p < 0.01$).

Observations and results

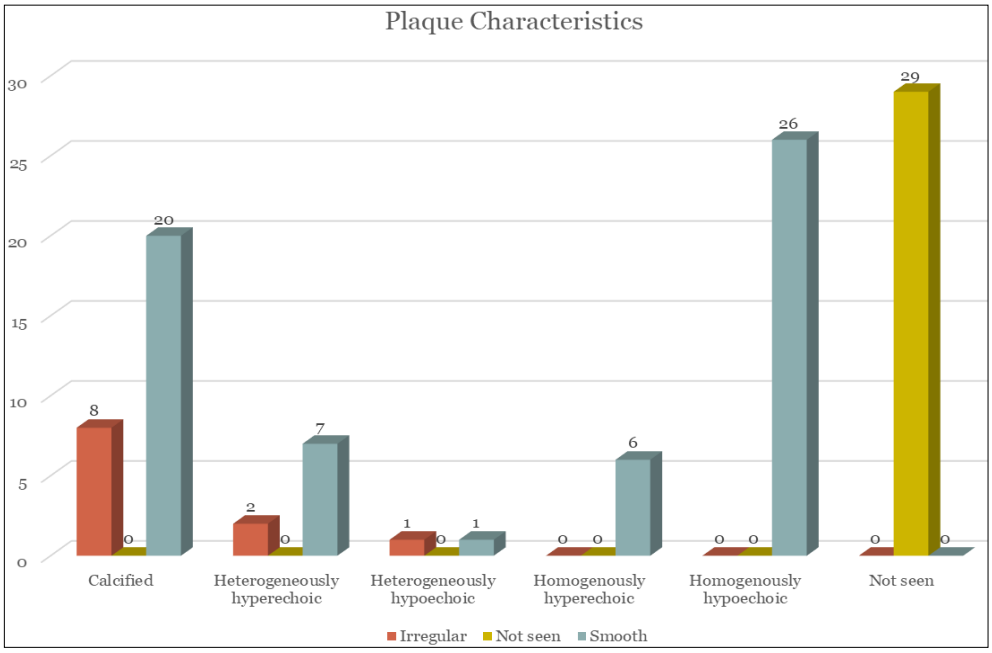

Fig 1

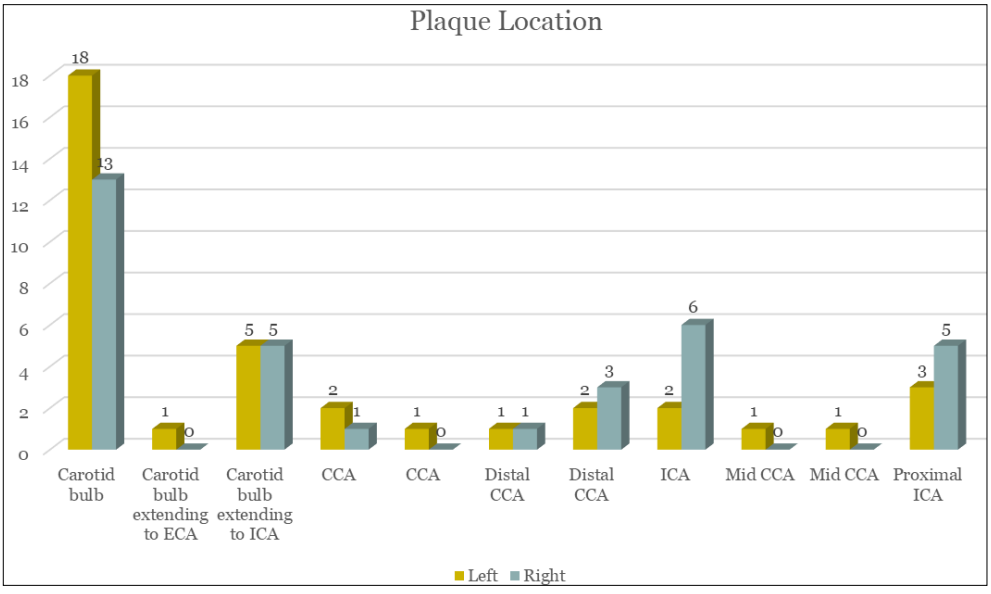

Fig 2

Table 1: Duplex criteria in relation with directly observed stenosis (right side)

% Area stenosis (Rt)	No. of Carotid Vessels	Rt ICA PSV(cm/s)		Rt ICA EDV(cm/s)		Rt ICA PSV/Rt CCA PSV	
		Mean	SD	Mean	SD	Mean	SD
<50	23	89.87	13.96	33.5128	3.7966	1.0769	0.2497
50-59	6	146.17	46.88	35.1667	5.1929	1.9333	0.4179
60-69	2	216.50	12.02	70	14.1421	2.5	0.2828
70-79	1	285.00	0.00	110	0.00	4.1	0.00
80-89	1	300.00	0.00	105	0.00	4.5	0.00
90-100	1	280.00	0.00	103	0.00	4.1	0.00
	34						

Images

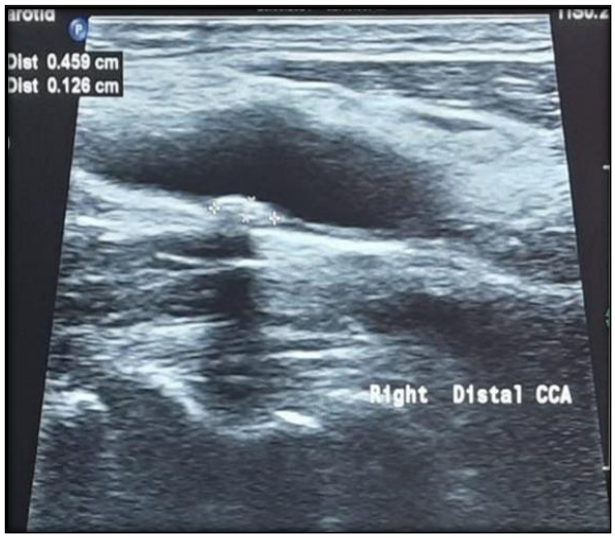

Fig 3: Gray scale image - hypoechoic plaque with irregular margin in right distal CCA

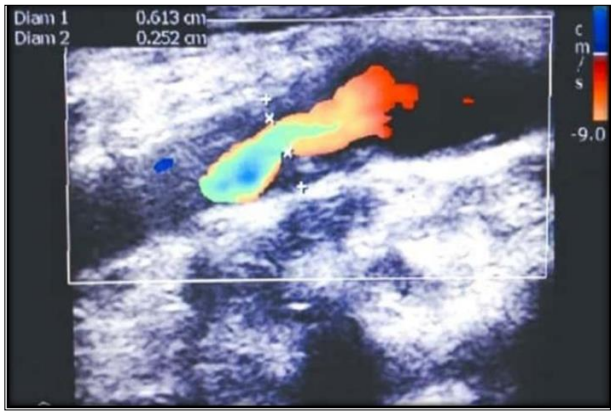

Fig 4: Colour Doppler images showing reduced colour flow with heterogeneously hyperechoic plaque in Left ICA causing 58.9 % area stenosis.

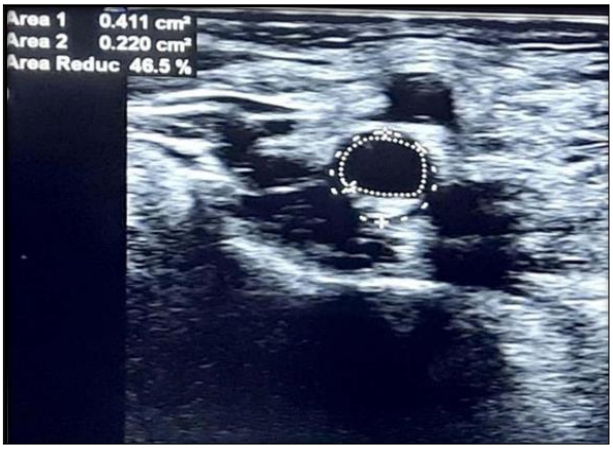

Fig 5: Gray scale axial image showing hyperechoic plaque with smooth margin causing 46.5% stenosis in left CCA

Discussion

The results of this investigation align with previous research highlighting the frequency of carotid artery stenosis in stroke victims [9]. Higher incidence of stenosis in male patients aligns with previous studies that suggest gender as one of the atherosclerotic disease risk factors [10].

Colour Doppler sonography proved to be an effective modality for the non-invasive assessment of carotid arteries. The ability to visualize both plaque morphology and blood flow dynamics permits a thorough assessment of stroke risk. This study supports the routine use of Doppler sonography in diagnostic examination of stroke individuals, particularly those at elevated likelihood of repeat incidents.

The cross-sectional design of the study, which restricts the capacity to infer causality, and the comparatively small sample size, which might have an impact on the findings' generalisability, are among its drawbacks. To better validate these findings, future research should concentrate on longitudinal studies with bigger populations and explore the role of carotid sonography in stroke prevention strategies.

Summary and conclusion

This study demonstrates high rate of carotid artery stenosis prevalence among stroke individuals and underscores the importance of routine carotid evaluation using colour Doppler sonography. Early detection of carotid artery stenosis can lead to timely interventions, potentially reducing the risk of recurrent strokes. Colour Doppler sonography should be considered an integral part of stroke management protocols in tertiary care settings.

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