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Original Article

Correlation of Clinical Parameters, Lipid Profile and Carotid and Vertebral Arteries Plaque as Detected by Doppler Ultrasound in Ischemic Stroke

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Abstract

Background: A stroke is caused by a disruption in blood flow to the brain, either from ischemia (blockage) or hemorrhage (rupture), and is a medical emergency. This study focuses on assessing carotid arteries using color Doppler sonography to evaluate stenosis and correlate cerebrovascular accidents with carotid artery status, clinical parameters, and lipid profiles.

Methods: It is a cross-sectional observational study that investigates the correlation between clinical parameters, lipid profile, and carotid and vertebral artery plaque in patients with ischemic stroke, using Doppler ultrasound amongst 65 patients.

Results: Out of 65 patients studied a significant portion of the study group (72.3%) were aged 51–70, with a male predominance (66.2%). Risk factors such as hypertension (47.7%), diabetes (43.1%), and dyslipidemia (41.5%) were prevalent. Doppler ultrasound findings revealed that most patients had peak systolic velocities between 125 and 200 cm/s (47.7%) and stenosis in the 50–70% range (47.7%). Hypoechoic plaques were more common than hyperechoic plaques, with hypoechoic plaques predominantly associated with 50–70% stenosis.

Conclusion: The study concludes that early detection and management of risk factors, along with carotid Doppler ultrasound, are critical in preventing ischemic stroke in high-risk patients. Carotid sonography, especially in individuals over 50 years with significant risk factors, is recommended for early diagnosis and intervention.

Key words: Carotid intima-media thickness, Doppler sonography, Ischemic stroke

INTRODUCTION

A stroke is a sudden loss of brain function caused by a disturbance in blood flow to the brain, either due to ischemia (blockage from thrombosis or embolism) or hemorrhage (rupture of a blood vessel).[1] It is a medical emergency and global health issue that can lead to permanent neurological damage, complications, and death if not promptly treated.[2]

Strokes are broadly classified into two types: Ischemic (accounting for 80% of cases) and hemorrhagic.[3] Key risk factors include diabetes, atherosclerosis, and carotid artery stenosis.[4] Patients with these comorbidities are at a higher risk of stroke.

Color Doppler sonography is an important non-invasive tool for evaluating the carotid arteries and identifying hemodynamically significant stenosis, which is critical for determining the need for surgical intervention like endarterectomy. Duplex sonography, combining high-resolution imaging with Doppler analysis, has largely replaced angiography for assessing carotid artery disease, as it is safer, less expensive, and non-invasive.[5]

While conventional carotid angiography remains the gold standard, it has drawbacks such as being invasive and costly. Besides identifying the degree of stenosis, ultrasound can characterize plaque composition, helping to detect plaques with a higher risk of embolization and can play a key role in preventing strokes, particularly through timely surgical intervention.[6] The brain is supplied by four vessels: The two internal carotid arteries (ICAs) and the two vertebral arteries.[7]

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This study was done to assess the carotid arteries with the help of color Doppler sonography and to correlate cerebrovascular accidents (CVAs) with extracranial carotid artery status with various clinical parameters and lipid profile.

Aims and Objectives

- The aims of this study were as follows: To explore the association of various clinical parameters, risk factors, and lipid profile values with ischemic stroke and corresponding carotid Doppler findings.

METHODS

It is a cross-sectional study done in the Medicine department of MGM Medical College and LSK Hospital from September 1, 2022, to April 30, 2024 for a period of 16 months. Based on the study done by Feigin *et al*. in 2021[8], the sample size calculated and final sample size was 65. Patient aged 25–70 years of either sex were included in the study based on the following criteria.

Inclusion Criteria

- The study was conducted on patients having ischemic stroke admitted as indoor patients of the medicine ward in MGM Medical College and LSK Hospital Kishanganj, Bihar.

Exclusion Criteria

- Non-consenting patients.
- Patients unable to understand the questionnaire.
- Critically ill patients admitted in intensive care unit.
- Patients with findings of old infarcts and hemorrhagic stroke.
- Patients with rheumatic heart disease, vasculitis, connective tissue disorder, or on statin therapy.
- Patients with a history of recurrent strokes or recent myocardial infarction.

A detailed clinical examination and history of patients presenting with features suggestive of CVA (neurological dysfunction, sudden loss of consciousness, altered sensorium, aphasia, slurring of speech, paralysis, or paresis) would be considered as the study sample and be included after confirmatory diagnosis of ischemic stroke is established via neuroimaging (computed tomography or magnetic resonance imaging brain). Thorough general examination and detailed neurological examination would be performed. Routine blood investigations were done along with fasting lipid profile.

Carotid Doppler study using a high-frequency imaging probe with a color Doppler facility has been used for visualization of vessel anatomy and vascular pathology.

Table 1: Demographic, Clinical and Risk factors profile of the study population

Age in Years	No of Cases	Percentage
25-40	07	10.8
41-50	11	16.9
51-60	24	36.9
61-70	23	35.4
Total	65	100
Sex Distribution	**No of Cases**	**Percentage**
Male	43	66.3
Female	22	33.8
Total	65	100
Clinical Features	**No of Cases**	**Percentage**
Right Hemiparesis	34	52.3
Left Hemiparesis	28	43.1
Aphasia	21	32.3
Cranial Nerve Palsy	50	76.9
Monoparesis	3	4.6
Risk Factors	**No of Cases**	**Percentage**
Diabetes	28	43.1
Hypertension	31	47.7
Dyslipidemia	27	41.5
Smokers	38	58.5
Alcoholic	12	18.5

Table 2: Radiological feature of the study population

Variable	No of cases	Percentage
Peak Systolic velocity (cm/sec)		
< 125	22	33.8
125-200	31	47.7
>200	12	18.5
End diastolic velocity (cm/sec)		
< 40	22	33?8
40-100	30	46.2
> 100	13	20.0
Carotid Index		
< 2.0	23	35.4
2.0-4.0	30	46.2
> 4.0	12	18.5
No of plaques		
1	30	46.2
2	14	21.5
3	04	6.2
Diameter of stenosis based on color doppler		
< 50%	13	20.0
50-70%	31	47.7
> 70%	11	16.9

Ischaemic stroke	Percentage of Stenosis		
	50-70%	<50%	Total
Hypoechoic	25	16	49
Hyperechoic	6	7	16
Total	31	23	65

Common carotid arteries, internal carotids, external carotids, and vertebral arteries were assessed in carotid Doppler study. Carotid intima-media thickness (CIMT) was analyzed (normal value 0.7–0.8 mm, Abnormal >1.1 mm).

Table 3: Correlation of various parameters with abnormal carotid intima-media thickness

CIMT (n=42)	Hypertension (n=31)		
	Present	Absent	Total
Present	31	11	42
Absent	0	23	23
Total	31	34	65
Statistical Interference	Chi-Square-26.8068 p value-0.0001		
CIMT (n=42)	**Dyslipidemia (n=27)**		
	Present	**Absent**	**Total**
Present	20	22	42
Absent	7	16	23
Total	27	38	65
Statistical Interference	Chi-Square-1.8071 p value-0.178		
CIMT (n=42)	**Diabetes (n=28)**		
	Present	**Absent**	**Total**
Present	26	16	42
Absent	2	21	23
Total	28	37	65
Statistical Interference	Chi-Square-17.15942 p value-<0.0001		
CIMT (n=42)	**Smoker (n=38)**		
	Present	**Absent**	**Total**
Present	30	12	42
Absent	8	15	23
Total	38	27	65
Statistical Interference	Chi-Square-8.21855 p value-0.004		
CIMT (n=42)	**Alcohol abusers (n=12)**		
	Present	**Absent**	**Total**
Present	5	37	42
Absent	7	16	23
Total	12	53	65
Statistical Interference	Chi-Square-8.21855 p value-0.004		
CIMT (n=42)	**Male (n=43)**		
	Present	**Absent**	**Total**
Present	34	08	42
Absent	9	14	23
Total	43	22	65
Statistical Interference	Chi-Square-11.6093 p value-0.0006		
CIMT (n=42)	**Female (n=22)**		
	Present	**Absent**	**Total**
Present	8	34	42
Absent	14	9	23
Total	22	43	65
Statistical Interference	Chi-Square-11.60934 p value-0.0006		

We also analyzed peak systolic velocity (cm/s), end-diastolic velocity (cm/s), and carotid index.

The data collected were entered into an Excel sheet and analyzed using MS Excel and SPSS version 26.0.

RESULTS AND ANALYSIS

Out of 65 cases, majority (72.3%) of cases were in the 51–70 years of age group, with a mean age of 57.26 years. Forty-three cases (66.2%) were male and 22 cases (33.8%) were female. Thirty-four (52.3%) patients presented with right hemiplegia, followed by left hemiplegia 28 (43.1%), aphasia 21 (32.3%), and monoparesis 3 (4.6%). Hypertension and diabetes were the most prevalent risk factor in our study population, we have found 47.7% of cases were hypertensive, 43.1% of cases were suffering from diabetes, and 41.5% of cases of dyslipidemia. Smoker and alcohol abusers were 58.5 and 18.5% of cases, respectively.

On radiological evaluation, we found majority of the subjects had peak systolic velocity ranged between 125 and 200 cm/s (47.7%), followed by <125 cm/s 33.8% and >200 cm/s (18.5%). Regarding end-diastolic velocity majority of the patients had end-diastolic velocity ranged between 40 and 100 cm/s (46.2%), followed by <40 cm/s (33.8%) and >100 cm/s (20%). Majority of the patients had 1 plaque (46.2%), followed by 2 plaques (21.5%), and 3 plaques (6.2%). Regarding the diameter of stenosis, we found majority of them had stenosis ranged between 50% and 70% (47.7%), followed by <50% (20%) and >70% (16.9%). Hypoechoic plaque (49 cases) was more prevalent than hyperechoic plaque (19 cases). Among hypoechoic plaque, 50–70% stenosis was most common (25 cases), followed by <50% stenosis (16 cases) and >70% stenosis (8 cases). While out of 19 cases of hyperechoic plaque, <50% stenosis was most common (7 cases), followed by 50–70% stenosis (6 cases) and >70% stenosis (3 cases).

All 31 hypertensive patients had abnormal CIMT there for hypertension is the strongest risk factor for abnormal CIMT ($P < 0.0001$). Twenty-six out of 28 diabetic patients had abnormal CIMT ($P < 0.0001$). Twenty out of 27 dyslipidemic patients had abnormal CIMT (not statistically significant, $P = 0.178$). Thirty out of 38 smokers had abnormal CIMT ($P = 0.004$). Five out of 12 alcohol users had abnormal CIMT ($P = 0.004$). Thirty-four out of 43 males and eight out of 22 females had abnormal CIMT ($P = 0.0006$) indicating that males are prone to develop ischemia stroke.

DISCUSSION

The World Health Organization defines stroke as a rapid onset of focal neurological symptoms lasting over 24 h or resulting in death, with a vascular origin. It is the second leading cause of death globally and a primary cause of disability in older adults, with ischemic stroke accounting for 50–85% of cases.[9] Ischemic strokes are primarily

thromboembolic, often originating from carotid plaques, with atherosclerosis in carotid vessels responsible for about 80% of strokes.[10] The risk of major stroke is heightened in the first 3 months following a transient ischemic attack (TIA), with a significant number of strokes preceded by TIAs.[11]

CIMT has emerged as a key independent marker for ischemic stroke. The NASCET study indicates that carotid endarterectomy can significantly reduce the risk of stroke compared to medical therapy, particularly in symptomatic patients with significant carotid stenosis.[12] Doppler ultrasound is a cost-effective, non-invasive method for diagnosing carotid stenosis and assessing plaque morphology, leading to the early identification of at-risk patients and the potential for preventive measures.[13]

In this study, 65 patients with ischemic stroke were evaluated. Most cases (72.3%) were found in the 51–70 year age group, with a male predominance (66.2%). The average age was 57.26 years. Right hemiplegia was the most common (52.3%) clinical feature, followed by left hemiplegia (43.1%), and aphasia (32.3%). Key risk factors included hypertension (47.7%), diabetes (43.1%), and dyslipidemia (41.5%). Carotid Doppler Findings: Most patients had a peak systolic velocity between 125 and 200 cm/s (47.7%). The majority exhibited one plaque (46.2%) and stenosis between 50% and 70% (47.7%). Hypoechoic plaques (49 cases) were more common than hyperechoic plaques (19 cases). Among hypoechoic plaques, 50–70% stenosis was most prevalent. Out of the 42 patients with abnormal CIMT, 31 had hypertension, 26 had diabetes, and 30 were smokers, indicating these conditions as significant risk factors. Out of 27 patients with dyslipidemia 20 had abnormal CIMT and 7 had normal CIMT.

CONCLUSION

The study noted a significant association between various risk factors and the presence of carotid artery disease, with hypertension being particularly prevalent among those with abnormal CIMT. Managing and identifying risk factors early is crucial for slowing the progression of carotid artery disease and preventing strokes, particularly in asymptomatic patients.

The role of carotid sonography in detecting the site and morphology of plaque and quantifying the degree of stenosis is well justified, especially in high-risk patients. Radiological findings such as peak systolic and end-diastolic velocities were consistent with a high degree of carotid stenosis. Plaque analysis showed that hypoechoic plaques were more common than hyperechoic ones, indicating that plaque morphology could inform treatment decisions.

Overall, carotid Doppler ultrasound findings are vital for the prevention and management of ischemic strokes in high-risk patients. Hence, patients aged above 50 years with the risk factors mentioned in the study should undergo screening of extracranial carotid arterial system by duplex sonography.

Ethical Approval

Taken.

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