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Research Article

COMPARATIVE ANALYSIS OF LIPID PROFILE IN PATIENTS WITH HEMORRHAGIC VERSUS ISCHEMIC STROKE: A CROSS-SECTIONAL STUDY

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ABSTRACT

Objective: Stroke is a major cause of morbidity and mortality worldwide resulting from either an ischemic insult or rupture of a blood vessel in the brain. It not only leads to significant physical disability but also imposes emotional and economic burdens on patients and their families. Assessing the lipid profile in stroke patients is crucial, especially in ischemic stroke, where dyslipidemia plays a key role in atherosclerosis development. Elevated low-density lipoprotein (LDL) and triglycerides (TG) are important modifiable risk factors, and managing these can reduce the incidence and recurrence of strokes. Comprehensive lipid management should be a core component of stroke prevention and treatment strategies.

Methods: This was a cross-sectional study in which 80 adult stroke patients (40 ischemic and 40 hemorrhagic strokes) were included on the basis of a predefined inclusion and exclusion criteria. The diagnosis of stroke was made on the basis of imaging and neurological examination. A comprehensive medical history, physical measurements (including body mass index), and lipid profiles (total cholesterol [TC], LDL, High-density lipoprotein [HDL], and TG) were recorded for all participants. Blood samples were taken after overnight fasting to ensure accuracy. Statistical analysis using SPSS version 21.0 compared lipid levels between the groups. An unpaired t-test and Chi-square test were used, with significance defined as a $p<0.05$.

Results: There was a significant difference in lipid profiles between ischemic and hemorrhagic stroke patients. Ischemic stroke patients had markedly higher levels of LDL with a mean of 129.84±36.54 mg/dL compared to 106.32±26.68 mg/dL in hemorrhagic stroke patients (p=0.0015). TC levels were also significantly elevated in ischemic stroke patients, averaging 236.22±56.26 mg/dL versus 196.48±46.24 mg/dL in hemorrhagic stroke patients (p=0.0009). Total TG were higher in ischemic stroke patients (158.54±44.68 mg/dL) compared to hemorrhagic stroke patients (128.62±39.16 mg/dL, p=0.0021). HDL levels were slightly lower in ischemic stroke patients (34.54±8.26 mg/dL) compared to hemorrhagic stroke patients (38.12±9.12 mg/dL), although this difference was not statistically significant (p=0.0696).

Conclusion: There were significant differences in lipid profiles between ischemic and hemorrhagic stroke patients. Ischemic stroke patients had higher levels of LDL, TC, and TG, indicating a stronger association with dyslipidemia and atherosclerosis. These findings highlight the importance of aggressive lipid management in ischemic stroke patients to reduce recurrence risk and improve outcomes.

Keywords: Stroke, Embolism, Dyslipidemia, Hemorrhage, Hypertension.

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INTRODUCTION

Stroke is one of the leading causes of morbidity and mortality worldwide and imposes a significant global health burden. Stroke is caused by an interruption in the blood supply to the brain secondary either to blockage or rupture of a blood vessel. According to the World Health Organization (WHO), approximately 15 million people suffer from strokes each year, of which around 5 million die and another 5 million are left permanently disabled [1]. The impact of stroke extends beyond physical disability as it also leads to emotional, social, and economic challenges for both patients and their families. This highlights the critical need for effective prevention strategies such as timely diagnosis and appropriate management to mitigate the devastating effects of stroke. Stroke subtypes, including ischemic and hemorrhagic differ in their pathophysiology, clinical presentation as well as prognosis. Understanding the underlying mechanisms and associated risk factors for each type of stroke is vital for improving patient outcomes [2].

Strokes are broadly classified into two main types ischemic and hemorrhagic. Ischemic stroke accounts for about 85% of all cases and hemorrhagic stroke, which constitutes remaining 15%, is caused by the rupture of intracranial blood vessels. Hemorrhagic strokes are further categorized into intracerebral hemorrhage and subarachnoid hemorrhage. Predisposing factors for ischemic stroke include hypertension, diabetes mellitus, atrial fibrillation, smoking, and dyslipidemia, while those for hemorrhagic stroke include uncontrolled hypertension, vascular malformations, and aneurysms. The risk factors for both types of strokes often overlap yet the mechanisms by which they contribute to each type of stroke differ [3].

Among the modifiable risk factors for stroke, dyslipidemia plays a particularly important role. Dyslipidemia characterized by abnormalities such as elevated low-density lipoprotein (LDL), low high-density lipoprotein-cholesterol (HDL-C), and elevated triglycerides (TG) has been strongly associated with the development of atherosclerosis which is the primary mechanism behind ischemic stroke. Elevated LDL-C levels promote the formation of atherosclerotic plaques in the blood vessels which can eventually rupture or embolize causing an ischemic event. Conversely, hemorrhagic strokes are more strongly associated with chronic hypertension. Addressing lipid profile abnormalities is a crucial aspect of stroke prevention and management. Other modifiable risk factors include hypertension, smoking, obesity, physical inactivity, and diabetes mellitus. Among these, dyslipidemia stands out as a key target for intervention due to its significant role in the pathophysiology of ischemic stroke [4].

When comparing lipid profiles between patients with ischemic and hemorrhagic stroke several differences emerge. In patients with ischemic stroke, dyslipidemia is more commonly observed, particularly elevated LDL-C and TG as well as decreased HDL-C levels [5]. These lipid abnormalities contribute to the development and progression of atherosclerosis, increasing the likelihood of thromboembolic events. In contrast, patients with hemorrhagic stroke often have relatively normal or mildly elevated cholesterol levels. The contrasting lipid profiles between ischemic and hemorrhagic stroke patients emphasize the need for a tailored approach to lipid management in each stroke subtype [6].

Early intervention in cases of dyslipidemia is critical for reducing stroke incidence, morbidity, and mortality. Aggressive lipid-lowering therapy has been associated with improved outcomes in stroke patients including a reduction in major cardiovascular events and improved survival [7]. In patients with ischemic stroke, initiating lipid-lowering therapy early in the course of treatment has been shown to significantly reduce the risk of recurrent stroke and other vascular events. While the role of lipid-lowering therapy in hemorrhagic stroke remains less clear, maintaining an optimal lipid balance is important for overall vascular health. Therefore, dyslipidemia should be diagnosed and aggressively managed in all stroke patients, particularly those with ischemic stroke, to reduce the burden of recurrent stroke and improve long-term outcomes [3].

This study aims to compare lipid profiles in patients with hemorrhagic versus ischemic stroke, with the goal of identifying specific lipid abnormalities seen in individuals of each stroke subtype.

METHODS

This was a cross-sectional study comprising 80 adult patients diagnosed with stroke, out of which 40 had ischemic stroke and 40 had hemorrhagic stroke, based on findings from brain computed tomography (CT) scans. The study was conducted in the Department of General Medicine at a tertiary care medical institute. The sample size for this study was determined based on a pilot study examining lipid profiles in patients with different types of stroke. To achieve a power of 90% and a confidence interval of 95%, the minimum sample size required was 74 patients. Therefore, we included 80 patients (40 patients with embolic stroke and 40 patients with hemorrhagic stroke) in our study.

Diagnosis of ischemic and hemorrhagic stroke was done on the basis of CT imaging. A detailed medical history was obtained for all participants, including age, sex, past medical history, medication use, lifestyle habits such as smoking and alcohol consumption, and any comorbid conditions such as hypertension or diabetes. Key physical measurements, such as height, weight, and body mass index (BMI), were recorded for each individual. Lipid profile was done in all cases including measurements of total cholesterol (TC), TG, LDL cholesterol (LDL-C), and HDL-C. Blood samples were collected in the morning following an overnight fast to ensure the accuracy of the lipid measurements. The lipid levels were evaluated using standard laboratory methods, and reference ranges were applied to classify the results as normal or abnormal.

The correlation between lipid profile parameters and stroke type (ischemic vs. hemorrhagic) was analyzed. Patients were grouped based on their stroke diagnosis and their lipid profile results were compared between the two groups to determine if there were significant differences in lipid levels.

Statistical analysis was performed using SPSS version 21.0 software. Quantitative data, such as lipid levels, were presented as mean and standard deviation, while qualitative data, such as stroke type, were presented with incidence and percentage tables. An unpaired t-test was applied to compare quantitative data between the two groups, and a Chi-square test was used for qualitative data. A $p<0.05$ was considered statistically significant.

Inclusion criteria

1. Patients diagnosed to be having ischemic or hemorrhagic stroke on the basis of CT brain
2. Age above 18 years
3. Patients or caretakers ready to give informed and written consent to be part of the study.

Exclusion criteria

1. Age <18 years
2. Refusal to give consent to be part of study
3. Patients with previous history of stroke
4. Patients on lipid-lowering medications such as statins or fibrates
5. Patients with significant hepatic or renal dysfunction or those with significant psychiatric illnesses.

RESULTS

The analysis of the gender distribution of the cases showed that ischemic stroke occurred more frequently in males with 29 cases (72.5%) compared to 11 cases (27.5%) in females. Similarly, hemorrhagic stroke was also more common in males (67.5%) as compared to in females (32.5%). Overall, out of 80 total stroke cases, 56 were male (70.0%) and 24 were female (30.0%). The gender distribution of ischemic as well as hemorrhagic stroke cases was found to be comparable with no statistically significant difference ($p=0.8076$) (Table 1).

The gender-wise age distribution of stroke cases revealed that in both ischemic and hemorrhagic stroke groups males were more affected than females. In Group A (ischemic stroke), 72.5% of the cases were males, with the majority aged above 50 (30%), while females accounted for 27.5% primarily aged above 50 (7.5%). In Group B (hemorrhagic stroke), males made up 67.5% of cases with 32.5% aged above 50. In Group B, females constituted 32.5% with 12.5% in the above 50 age group. The comparison of age-wise gender distribution showed that the mean age of male and female patients in both groups was comparable with no statistically significant difference ($p>0.05$) (Table 2).

The analysis of the presence of diabetes and hypertension in ischemic and hemorrhagic stroke cases showed that diabetes was present in seven ischemic stroke patients (17.5%) and nine hemorrhagic stroke patients (22.5%), while it was absent in 33 ischemic stroke patients (82.5%) and 31 hemorrhagic stroke patients (77.5%). Hypertension was observed in 17 ischemic stroke patients (42.5%) and 24 hemorrhagic stroke patients (60%), whereas it was absent in 23 ischemic stroke patients (57.5%) and 16 hemorrhagic stroke patients (40%) (Fig. 1).

The analysis of systolic and diastolic blood pressure, fasting blood sugar levels, and BMI revealed significant differences between ischemic and hemorrhagic strokes. Hemorrhagic stroke patients had significantly higher systolic blood pressure (152.48±32.22 mm Hg vs. 132.22±24.36 mm Hg, $p=0.002$) and diastolic blood pressure (98.86±18.92 mm Hg vs. 86.46±12.28 mm Hg, $p=0.0008$) compared to ischemic stroke patients. Although fasting blood sugar levels were slightly higher in hemorrhagic stroke patients (116.72±21.74 mg/dL vs. 110.64±19.34 mg/dL), the difference was not statistically significant ($p=0.1902$). In addition, BMI was significantly higher in hemorrhagic stroke patients (30.02±9.24 kg/m^2) compared to ischemic stroke patients (24.88±7.12 kg/m^2, $p=0.0067$) (Table 3).

The analysis of the lipid profile in relation to the type of stroke reveals significant differences between ischemic and hemorrhagic strokes. Patients with ischemic stroke were found to have a higher mean level of LDL (129.84±36.54) as compared to hemorrhagic stroke patients (106.32±26.68) and the difference was statistically significant ($p=0.0015$). HDL levels were slightly lower in ischemic stroke patients (34.54±8.26) as compared to hemorrhagic stroke patients (38.12±9.12) but the difference was not statistically significant ($p=0.0696$). Total TG were higher in ischemic stroke cases (158.54±44.68) compared to hemorrhagic stroke (128.62±39.16) and the difference was statistically significant. TC levels were also significantly elevated in ischemic stroke patients (236.22±56.26) versus hemorrhagic stroke patients (196.48±46.24) ($p=0.0009$). Overall, LDL, total TG, and TC showed statistically significant differences between the two stroke types (Table 4).

Table 1: Gender distribution of cases in ischemic versus embolic stroke

	Males		Females	
	Number of cases	Percentage	Number of cases	Percentage
Ischemic stroke	29	72.5	11	27.5
Hemorrhagic stroke	27	67.5	13	32.5
Total	56	70.0	24	30.0

p=0.8076 (not significant)

Table 2: Gender-wise age distribution of studied cases

Gender-wise age distribution	Males		Females		
	Number	Percentage	Number	Percentage	
Group A (Ischemic stroke)					
18–30	2	5	1	2.5	p=0.4869 not significant
31–40	5	12.5	3	7.5%	
41–50	10	25	4	10	
Above 50	12	30	3	7.5	
Total	29	72.5	11	27.5	
Mean age	57.28±8.64		59.46±9.12		
Group B (Hemorrhagic Stroke)					
18–30	1	2.5	1	2.5	p=0.1875 not significant
31–40	4	10	2	5	
41–50	9	22.5	5	12.5	
Above 50	13	32.5	5	12.5	
Total	27	67.5	13	32.5	
Mean age	56.6±9.44		60.98±10.14		

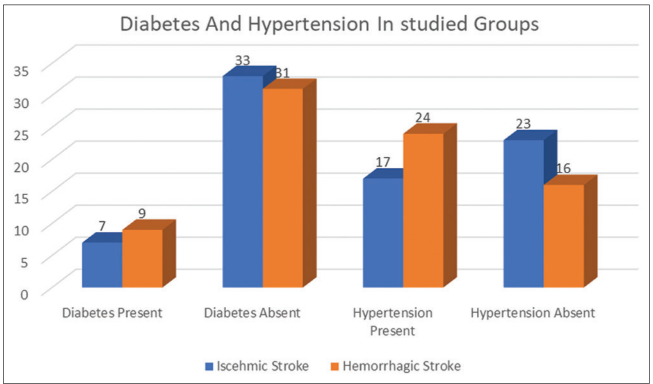

Fig. 1: Diabetes and hypertension in cases of stroke

DISCUSSION

Stroke is a leading cause of morbidity and mortality worldwide and its association with dyslipidemia is well-established. Elevated levels of LDL cholesterol, TC, and TG along with reduced HDL levels have been implicated in the development of stroke. Lipid profile assessment therefore plays a crucial role in identifying patients at risk for both ischemic and hemorrhagic strokes. Monitoring and managing lipid levels are essential components of stroke prevention strategies as they help in deciding treatment approaches. The interventions such as lipid-lowering therapies can reduce stroke recurrence and improve overall cardiovascular health. By understanding the specific lipid abnormalities associated with each stroke subtype, treating physicians can better predict outcomes and implement early interventions that may mitigate the severity of the stroke or prevent further complications [8].

In both ischemic and hemorrhagic stroke groups, males were predominantly affected than females, with 72.5% of ischemic and 67.5% of hemorrhagic cases being male. Most affected individuals in both groups were aged above 50. The mean age of male patients was 57.28 years (±8.64) for ischemic stroke and 56.6 years (±9.44) for hemorrhagic stroke. In contrast, female patients had mean ages of 59.46 years (±9.12) in ischemic stroke and 60.98 years (±10.14) in hemorrhagic stroke. The mean age of male and female patients was found to be comparable in both groups (p>0.05). Jungehülsing *et al.* conducted a population-based survey to determine the prevalence of stroke and stroke symptoms [9]. The study involved 75,720 households where participants aged ≥50 received a stroke symptom questionnaire. A total of 28,090 individuals responded (37.5%). Stroke prevalence was reported by 4.5% based on physician diagnosis, increasing to 7.6% when stroke history was combined with visual and articulation issues. Stroke prevalence was higher in men (8.4%) than women (7.2%). Risk factors included advanced age, male gender, non-German nationality, and lower education. Based on these findings, the authors concluded that combining stroke history with symptom reporting provides a reliable method for assessing prevalence. Similar male predominance in the case of stroke has also been reported by authors such as Giralt *et al.* [10] and Itzhaki *et al.* [11].

In this study, hemorrhagic stroke patients had significantly higher systolic (152.48±32.22 mm Hg) and diastolic blood pressures (98.86±18.92 mm Hg) compared to ischemic stroke patients (132.22±24.36 mm Hg and 86.46±12.28 mm Hg, respectively). While fasting blood sugar levels were slightly elevated in hemorrhagic stroke cases, the difference was not statistically significant. However, BMI was notably higher in hemorrhagic stroke patients (30.02±9.24 kg/m^2) compared to ischemic stroke patients (24.88±7.12 kg/m^2). Moosa *et al.* conducted a retrospective cross-sectional hospital-based study to compare stroke incidence, risk factors, and outcomes between young adults and the elderly [12]. The study reviewed stroke patients from 2018 to 2020, with a diagnosis confirmed by ICD-10 classification. It was found that individuals under 45 years of age had a significantly higher incidence of hemorrhagic stroke (p=0.011), and hypertension was a leading cause, particularly in the younger cohort (19.4% vs. 7.5% in older groups, p=0.001). Based on these findings, the authors concluded that hypertension is a major risk factor for stroke in young adults. Hypertension as a major risk factor for hemorrhagic stroke has also been reported by the authors such as Wajngarten and Silva [13] and Woo *et al.* [14].

From the perspective of ischemic stroke and its risk factors, Gajurel *et al.* conducted a secondary analysis of a prospective observational

Table 3: Comparison of blood pressures, fasting blood sugar values, and body mass index

Lipid profile	Type of stroke	Mean±SD	p-value
Systolic blood pressure (mm of hg)	Ischemic stroke Hemorrhagic stroke	132.22±24.36 152.48±32.22	p=0.002*
Diastolic blood pressure (mm of hg)	Ischemic stroke Hemorrhagic stroke	86.46±12.28 98.86±18.92	p=0.0008*
Fasting blood sugar levels (mg/dL)	Ischemic stroke Hemorrhagic stroke	110.64±19.34 116.72±21.74	p=0.1902
Body mass index (kg/m^2)	Ischemic stroke Hemorrhagic stroke	24.88±7.12 30.02±9.24	p=0.0067*

Table 4: Comparison of lipid profile in ischemic versus hemorrhagic stroke

Lipid profile	Type of stroke	Mean±SD	p-value
Low-density lipoprotein	Ischemic stroke Hemorrhagic stroke	129.84±36.54 106.32±26.68	p=0.0015*
High-density lipoprotein	Ischemic stroke Hemorrhagic stroke	34.54±8.26 38.12±9.12	p=0.0696
Total triglycerides	Ischemic stroke Hemorrhagic stroke	158.54±44.68 128.62±39.16	p=0.0021*
Total cholesterol	Ischemic stroke Hemorrhagic stroke	236.22±56.26 196.48±46.24	p=0.0009*

study to examine the prevalence of dyslipidemia and central obesity in ischemic stroke patients [15]. Data from 145 patients were analyzed, showing that 96.6% had dyslipidemia, with LDL cholesterol being the most common abnormality (82.8%). Central obesity was present in 57.9% of patients and was significantly associated with female gender (p=0.003) and diabetes (p=0.012). On the basis of these findings, the authors concluded that dyslipidemia and central obesity are highly prevalent in ischemic stroke patients, with obesity linked to gender and diabetes. Similar risk factors for embolic strokes were also reported by authors such as Perkins *et al*. [16] and Boehme *et al.* [3].

In this study, ischemic stroke patients had significantly higher levels of LDL (129.84±36.54 mg/dL) compared to hemorrhagic stroke patients (106.32±26.68 mg/dL, p=0.0015). TC (236.22±56.26 mg/dL vs. 196.48±46.24 mg/dL, p=0.0009) and TG (158.54±44.68 mg/dL vs. 128.62±39.16 mg/dL) were also significantly elevated in ischemic strokes. HDL levels were slightly lower in ischemic stroke cases, but the difference was not statistically significant. Overall, lipid profile abnormalities were more prominent in ischemic stroke patients. Singh *et al*. conducted an observational comparative study to determine the difference in lipid profiles between ischemic and hemorrhagic stroke patients [17]. For this purpose, the authors undertook a study comprising 128 stroke patients admitted to SMS Hospital, 64 with ischemic stroke and 64 with hemorrhagic stroke. The study found that ischemic stroke patients had higher lipid derangements compared to hemorrhagic stroke patients. Raised serum TC was found in 39.1% of ischemic stroke patients compared to 18.8% of hemorrhagic stroke patients (p=0.019). In addition, 29.7% of ischemic stroke patients showed elevated LDL cholesterol compared to 9.4% of hemorrhagic stroke patients (p=0.007). Low HDL cholesterol was observed in 73.4% of ischemic stroke patients compared to 53.1% of hemorrhagic stroke patients (p=0.028). On the basis of these findings, the authors concluded that ischemic stroke patients exhibited more significant lipid derangements in terms of elevated TC, LDL cholesterol, and decreased HDL cholesterol. Similar lipid profiles in cases of stroke patients had also been reported by the authors such as Chang *et al* [18].

CONCLUSION

This study underscores the importance of assessing dyslipidemia in stroke patients as lipid profile abnormalities are known to be associated with stroke risk and outcomes. Dyslipidemia, particularly elevated LDL and cholesterol levels plays an important role in the development of ischemic stroke by contributing to atherosclerosis. Monitoring lipid levels can aid in identifying high-risk patients thereby guiding preventive strategies and optimizing stroke management. Effective control of dyslipidemia is crucial in reducing stroke recurrence and improving prognosis.

CONFLICTS OF INTEREST

None.

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