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Original Research Article

A STUDY ON CORRELATION BETWEEN SERUM CHOLESTEROL LEVELS AND TRIGLYCERIDES TO HDL CHOLESTEROL RATIO IN PATIENTS WITH HEMORRHAGIC TRANSFORMATION OF ISCHEMIC STROKE

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ABSTRACT

Background: Hemorrhagic transformation (HT) in acute ischemic stroke (AIS) is a critical complication that worsens prognosis. Identifying associations between serum lipid profiles and HT risk may improve predictive accuracy and patient outcomes.

Materials and Methods: This retrospective cohort study included 200 AIS patients, analyzing demographic characteristics, BMI, and fasting lipid profiles. The study assessed correlations between total cholesterol, LDL, triglycerides, HDL, and the triglyceride to HDL ratio (TG/HDL) with the incidence of HT. Statistical analysis involved t-tests and chi-square tests to evaluate significance, with $p < 0.05$ considered significant.

Results: The mean age of patients was 56.7 ± 7.1 years, with a male predominance (59%). HT occurred in 28.5% of cases. Patients with HT showed significantly lower mean LDL (157.3 ± 31.2 mg/dL) and HDL (40.0 ± 6.3 mg/dL) compared to non-HT patients. Additionally, HT patients had a higher TG/HDL ratio (4.8 ± 1.3) than non-HT patients (4.4 ± 0.7), with p-values <0.05. Higher BMI and older age also correlated with increased HT risk.

Conclusion: Low HDL levels, higher TG/HDL ratio, and obesity were significantly associated with HT in AIS patients, suggesting these lipid parameters could serve as useful markers in identifying HT risk. Targeting lipid management may improve outcomes in high-risk patients.

Keywords: Acute ischemic stroke, hemorrhagic transformation, lipid profile, HDL, TG/HDL ratio, Serum cholesterol.

INTRODUCTION

Acute ischemic stroke (AIS) is a leading cause of morbidity and mortality worldwide, representing a significant burden on healthcare systems and affecting millions of individuals globally each year.[1] Characterized by a sudden reduction in cerebral blood flow due to an occlusion in one or more cerebral arteries, AIS disrupts the supply of oxygen and nutrients to brain tissues, resulting in ischemia and subsequent tissue damage.[2]

Among the various complications that can arise in AIS, hemorrhagic transformation (HT) is a critical adverse event that poses challenges for effective management. Hemorrhagic transformation refers to the conversion of ischemic brain tissue into hemorrhagic regions, often exacerbated by reperfusion therapies or spontaneous reperfusion.[3] This transformation not only worsens neurological outcomes but also limits the therapeutic options available to clinicians, making its prediction and prevention a vital area of research.[4]

The pathogenesis of HT in AIS is complex and multifactorial, involving mechanisms such as blood-

brain barrier disruption, inflammation, and oxidative stress5. Reperfusion, which is essential for salvaging ischemic brain tissue, can inadvertently increase the risk of HT by enhancing vascular permeability and leading to blood extravasation in the damaged cerebral tissues.[6] Identifying biomarkers that correlate with an increased risk of HT may thus help in refining treatment strategies and improving patient outcomes.

Several studies have indicated the potential role of lipid profiles in predicting adverse outcomes in stroke, including HT.[7] The serum profile in AIS patients often exhibits elevated levels of cholesterol and triglycerides, which may contribute to the pathophysiology of stroke and subsequent HT.[8] The ratio of total cholesterol to triglycerides/HDL cholesterol has been proposed as a marker for assessing cardiovascular risk and has recently been associated with poor outcomes in stroke patients.[9] Elevated total cholesterol and triglyceride levels, coupled with low HDL, are thought to exacerbate vascular damage, increasing the likelihood of HT in AIS patients.[10]

This study was conducted with an aim to determine the association of total cholesterol and triglycerides to HDL cholesterol ratio with hemorrhagic transformation(HT) in ischemic stroke patients.

MATERIALS AND METHODS

This study is a prospective cohort analysis, conducted in the Department of Neurology, NRI Medical College over a period of 6 months, i.e. from November 2022 to May 2023. The study included patients diagnosed with AIS based on clinical and radiological criteria who were admitted to the hospital during the study period. Patients aged 18 years and older were considered, while those with pre-existing intracranial hemorrhage, traumatic brain injury, or coagulopathy were excluded to isolate cases of HT specifically linked to AIS.

Data on baseline demographic and clinical characteristics (age, sex, comorbidities, and medication history) was collected. Serum cholesterol levels, including total cholesterol, TG, HDL, and low-density lipoprotein (LDL), was recorded within 24 hours of admission. Imaging data from CT and MRI scans was reviewed to identify HT, classified according to the European Cooperative Acute Stroke Study (ECASS) criteria.

Statistical Analysis: Descriptive statistics were used to summarize patient characteristics and lipid profiles. Continuous variables were presented as mean ± standard deviation, while categorical data were presented as frequencies and percentages. Pearson or Spearman correlation tests were used to assess the relationship between serum cholesterol levels and TG/HDL ratio with HT.

RESULTS

In present study 200 patients with acute ischemic stroke were included. Amongst the 200 patients, 60 patients (30%) had hemorrhagic transformation (HT). The mean age of the study population was 57.6 ± 8.1 years. Most of the patients belonged to the age group of 51-60 years (48%).

The study results reveal significant associations between demographic factors, lipid profiles, and the risk of hemorrhagic transformation (HT) in ischemic stroke patients. Age distribution indicated that older patients, particularly those between 51-60 years, had a higher prevalence of HT (17.5%), with a statistically significant correlation ($p = 0.007$). Gender analysis showed a higher occurrence of HT among males (24%) compared to females (6%), though this difference was not statistically significant ($p = 0.0657$). Obesity, defined as a BMI >25 kg/m², was also notably associated with an increased risk of HT, with 24.5% of obese patients experiencing HT compared to only 5.5% among those with a normal BMI ($p = 0.002$). [Table 1]

The lipid profile analysis further highlighted significant differences in lipid levels between patients with and without HT. Patients with HT had lower mean LDL (157.3 mg/dL) and triglyceride levels (182.7 mg/dL) compared to those without HT (168.1 mg/dL and 198.3 mg/dL, respectively), with p-values of 0.021 and 0.012. Cholesterol levels were also significantly lower in HT patients (228.8 mg/dL) than non-HT patients (252.3 mg/dL) ($p < 0.001$). Notably, lower HDL levels and a higher TG/HDL-C ratio were linked to HT risk, with mean HDL levels of 40.0 mg/dL in HT patients versus 46.0 mg/dL in non-HT patients ($p < 0.001$) and a TG/HDL-C ratio of 4.8 in HT patients compared to 4.4 in non-HT patients ($p = 0.034$). [Table 2]

Table 1: Demographic Factors

Characteristics		Frequency	No. of patients with HT	P value
Age distribution	21-30 years	4 (2%)	0	0.007
	31-40 years	14 (7%)	2 (1%)	
	41-50 years	52 (26%)	10 (5%)	
	51-60 years	96 (48%)	35 (17.5%)	
	>60 years	34 (17%)	13 (6.5%)	
Gender	Males	120 (60%)	48 (24%)	0.0657
	Females	80 (40%)	12 (6%)	
BMI	18.5 – 24.9 (normal BMI	82 (41%)	11 (5.5%)	0.002
	>25 kg/m^2(obese)	118 (59%)	49 (24.5%)	

Table 2: Lipid Profile

Serum lipid profile	Patients with HT	Patients without HT	P value
Mean LDL levels (mg/dl)	157.3 ± 31.2	168.1 ± 29.1	0.021
Mean triglycerides levels (mg/dl)	182.7 ± 41.0	198.3 ± 38.2	0.012
Mean cholesterol levels (mg/dl)	228.8 ± 38.4	252.3 ± 33.1	<0.001
Mean HDL levels (mg/dl)	40.0 ± 6.3	46.0 ± 5.1	<0.001
Mean TG/HDL-C Ratio	4.8 + 1.3	4.4 + 0.7	0.034

DISCUSSION

The findings of this study reveal several notable associations between demographic factors, lipid profiles, and the risk of hemorrhagic transformation (HT) in acute ischemic stroke (AIS) patients, aligning with and expanding on findings from similar studies in this field. The significant association between age and HT observed in this study, particularly among patients aged 51-60 years, parallels findings from studies by Bang et al,[11] who also identified increased HT risk in older age groups, which may be due to age-related vascular and metabolic changes. However, unlike some studies where age was an independent risk factor, our study found that gender did not significantly influence HT risk, although there was a higher prevalence among males. This aligns with findings from Arboixet al,[12] who reported that while males often experience higher rates of AIS, gender alone may not independently predict HT.

BMI emerged as a significant factor, with obese patients showing a markedly higher prevalence of HT compared to those with normal BMI. Obesity-related factors, such as inflammation and endothelial dysfunction, likely contribute to increased vascular vulnerability, supporting findings by Soareset al,[13] who similarly found a positive association between higher BMI and HT in stroke patients.

Lipid profile results in this study also demonstrate significant correlations with HT risk, consistent with previous research emphasizing the predictive value of lipid levels in AIS outcomes. Lower LDL and triglyceride levels among HT patients, as observed in our study, contrast with findings from Delgado et al,[14] where elevated LDL was associated with an increased risk of hemorrhagic complications. This discrepancy may be due to differences in patient populations or regional dietary factors influencing baseline lipid profiles. Our finding that HT patients had significantly lower HDL levels (40 mg/dL) aligns with studies such as that of Chen et al,[15] who reported that low HDL increases vascular fragility and may contribute to the increased risk of hemorrhagic transformation.

The TG/HDL-C ratio was notably higher in patients with HT, supporting its utility as an indicator of cardiovascular risk and stroke outcomes. This relationship corroborates the work of Muruetet al,[16] who reported that an elevated TG/HDL-C ratio correlates with adverse stroke outcomes, particularly hemorrhagic complications. As our findings show a mean TG/HDL-C ratio of 4.8 in HT patients, this supports the growing evidence that this ratio could be a useful marker for assessing HT risk in clinical settings.

CONCLUSION

In conclusion, this study supports the association between lipid profiles and HT in AIS patients, while age and obesity also emerged as significant factors. These findings contribute to the understanding of HT risk factors and align with the broader literature, reinforcing the importance of demographic and metabolic markers in managing ischemic stroke outcomes.

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Conflict Of Interest: The authors declare no conflicts of interest related to this study.

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