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RESEARCH ARTICLE

A STUDY OF ASSOCIATION OF SERUM LIPID PROFILE WITH STROKE SEVERITY ON ADMISSION

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ABSTRACT

A Study of Association Of Serum Lipid Profile With Stroke Severity On Admission. **Background:** Stroke is one of the leading cause of morbidity and mortality. WHO defined stroke as "rapidly developed clinical signs of focal disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than vascular origin." OBJECTIVES: To find out the association between different parameters of lipid profile, i.e. serum total cholesterol level, serum triglyceride level, serum LDL level, serum HDL level with that of stroke severity on admission.
Material& Methods: A randomized cross sectional study consisting of 150 stroke patients admitted in the department of Medicine, R.G.Kar. Medical College and Hospital, Kolkata from the period of 01.07.2014 to 31.06.2015 was done. Assessment of stroke severity was done by Scandinavian Stroke Scale. Serum fasting triglyceride, Serum fasting total cholesterol, Serum fasting LDL-C, Serum fasting HDL-C level measured between 12 and 36 hours after stroke onset.
Result: Out of 150 cases, 82.67% cases were found to be due to ischemic stroke and rest 17.33% due to intracerebral stroke. There is statistically significant positive correlation between serum Total Cholesterol Vs SSS Score, and serum LDL-Cholesterol Vs SSS Score and serum Triglyceride vs SSS Score in Ischemic Stroke patients respectively (0.432, 0.319, 0.809) & also in intracranial Hemorrhage patients respectively (0.887,0.839,0.867).Correlation between serum HDL-Cholesterol and SSS Score in Ischemic Stroke and Intracranial Hemorrhage patients were not statistically significant ($p > 0.05$).
Conclusion: Higher serum LDL-Cholesterol, Triglyceride and Total Cholesterol levels were independently associated with less severe stroke both in Ischemic Stroke (IS) and Intracerebral hemorrhage(ICH) cases.

INTRODUCTION

A stroke or cerebrovascular accident is defined by the abrupt onset of a focal neurological deficit, which is attributable to a focal vascular cause. Thus this definition is clinical.[1] Stroke, being a worldwide health problem, makes an important contribution to mortality, morbidity and disability in developed and developing countries.[1]

Stroke is the third most cause of death worldwide after coronary heart disease (CHD) and cancer of all types.[2,3] However, unlike the Caucasians, Asians have a lower rate of CHD and higher prevalence of stroke.[3,4] In developed countries, over 80% of cases of CVA occur over 60yrs of age, whereas in India about 1/5th of the all strokes occur below the age of 60yrs.[5]

Stroke is one of the leading causes of morbidity and mortality. Dysfunction of brain (Neurological deficit) manifests itself by various neurological signs and symptoms that are related to the extent and the site of area involved and to the underlying causes. These include

- Coma
- Hemiplegia
- Paraplegia
- Monoplegia
- Multiple cranial nerve paralysis, speech disturbances, cranial nerve paresis, sensory impairments etc.

Hemiplegia constitutes the main neurological disorder in about 90% of the patients. Cerebral thrombosis is the most frequent form of stroke encountered in clinical studies, followed by hemorrhage. Subarachnoid hemorrhage and

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cerebral embolism come next as regards both morbidity and mortality.[6] Although the prevalence of stroke appears to be comparatively less in India than in developed countries, it is likely to increase proportionally with the increase in life expectancy.[6-8]

There are a lot of factors which contribute the risk of development of Stroke. These are,

- Hypertension
- Atrial fibrillation
- Diabetes
- Smoking
- Hyperlipidemia
- Asymptomatic&Sypmtomatic carotid stenosis etc.

The risk factors of atherosclerosis are hypertension (systolic blood pressure>160mm of mercury and diastolic blood pressure>90mm of mercury), diabetes mellitus(history of the disease requiring drug or dietary treatment before stroke), previous history of transient ischemic attack, hyperlipidemia (triglyceride concentration>160 mg%, cholesterol concentration>230mg%, and/or high density lipoprotein<35mg%), smoking and peripheral vascular disease.[10-12] The use of oral contraceptive is associated with nine fold increased risk of cerebral infarction in women.[13] The collaborative group of study in young women found that the risk of stroke with the oral contraceptives rose sharply in women with hypertension or migraine and those who were heavy smokers.[13-15]

A number of well-designed prevalence studies of stroke have been carried out on adequate sample size. These studies were carried out form from 1980s to year 2001, and include studies form South India, Eastern part of India[9] and North India. Meta-analysis of these studies yielded weighted average of prevalence rates as 1.54/ 1000.[6,9] Inverse variance method for deriving weighted average was used. Thus large studies, which have smaller standard errors, are given more weight than smaller studies which have larger errors. This choice of weight minimizes the variability of the pooled estimate of prevalence rate. Age and sex wise distribution of cases and study population was available only from a few studies. This distribution has been given as required (for input in DISMOD analysis) in the latest available study. It may also be seen that prevalence rate of stroke reported by this study (1.47 per thousand) is very close to the weighted average of prevalence rates of all other studies (1.54 per thousand).[6] The MCCD data has tabulated deaths due to diseases of the nervous system into following categories;

- Meningitis
- Multiple sclerosis
- Epilepsy
- All other diseases of nervous system.

The deaths due to stroke are included among all other disease of nervous system and these have not been tabulated separately.

Among all the neurological disease of adult life stroke clearly ranks first in frequency and importance, as nearly 50% of all neurological disorder in general hospital are of this type. The bio pathologic approach to stroke will likely to guide the next generation of treatment and has already had an impact on the direction of research in the field. Despite valuable advances in stroke neurology all physicians have a valuable role to play in the prevention of stroke by encouraging the reduction of risk factors, such as hypertension, smoking and hyperlipidemia.

Among the causes of the stroke ICH comes third in frequency after embolism and thrombosis. In the Harvard Stroke Registry and Michael Reese Stroke Registry, 51% to 63% of patients of ICH had a smooth progression of symptoms whereas 34-38% of patients had maximum symptoms at onset.[17] The early progression of neurodeficit in many patients is frequently due to ongoing bleeding and enlargement of hematoma during the first few hours.[18] Patients with ICH uncommonly present with symptoms on awakening of sleep (15%).[17] An early decrease of consciousness is seen in nearly 50% of patients with ICH. Headache occurs in nearly 40% of patients with ICH.[17] Vomiting is an important diagnostic sign according to Harvard stroke registry, 49% of supratentorial ICH present with vomiting. Elevation of blood pressure often too very high levels occurs as many as 90% of patients. Seizure occurs in only 6% of patients and more common in lobar hemorrhage.

The diagnostic procedure of choice of stroke is CT scan.[19] It can clearly identify haemorrhage as well as can demonstrate the size and location of the hemorrhage and may reveal structural abnormalities such as aneurysm, capital AVM, brain tumors as well as can identify structural complications such as herniation, intra ventricular extension or hydrocephalus. (Level of evidence I, Grade A recommendation).[19] CT scan of brain is also helpful in initial imaging choice for suspected ischemic stroke but an infarction may not show any abnormality in CT scan for first several hours. MRI reliably documents the extent and location of in all areas of brain including posterior fossa and cortical surface.[20]

Eyal Shahar *et al* have shown in their study over an average follow-up of 10 years (142 704 person-years at risk), they documented clinical ischemic stroke in 305 participants (161 men and 144 women). After multivariable adjustment for stroke risk factors, categorical and spline regression analyses of the entire sample, as well as the sample of men alone, revealed weak and inconsistent associations between ischemic stroke and each of the 5 lipid factors. Among women, the most consistent findings were decreasing risk of ischemic stroke within the top half of the distribution of HDL cholesterol and increasing risk within the lower range of the triglyceride distribution.[16]

Though dyslipidemia is a well known risk factor for atherosclerosis and cerebrovascular accident but similar study related to association of serum lipid profile with stroke severity are lacking in India and this needs further study and evaluation.

METERIALS AND METHODS

This study was conducted in R.G.Kar Medical College and Hospital, Kolkata, India in the department of Medicine from the period of 01.07.2014 to 31.06.2015. All the patient provided informed consent and the study protocol was approved by the Ethical committee.

Study Population

150 stroke patients who were admitted in the department of Medicine were recruited. WHO definition of stroke was used for diagnosis. It was further supported in every patient by CT scan brain. Patients were included and excluded with the help of strict inclusion and exclusion criteria given below –

Inclusion Criteria*:* Patients with stroke admitted within 24 hours of stroke onset.

Exclusion Criteria*:* Those patients admitted after 24 hours of onset of stroke.

Patients diagnosed to be suffering from metabolic encephalopathy.

Those patients who are suffering from intracranial space occupying lesion.

Those patients who are suffering from head injury.

Pediatric population.

Sample Size*:* 150 patients

Study Design*:* Allocation of the patients done by random selection, Arterial hypertension was diagnosed when its presence was documented in medical records or when at least 2 readings of blood pressure were ≥140 mm Hg (systolic) or ≥90 mm Hg (diastolic) after the acute phase of stroke. Diabetes mellitus was diagnosed if its presence was documented in medical records or the patient was taking insulin or oral hypoglycemic agents. A patient was defined as a smoker if there was a history of cigarette smoking during the past 5 years[23]. Confirmation of diagnosis by CT SCAN of brain, Association between stroke severity (SCANDINAVIAN STROKE SCALE) [24] and fasting serum lipid profile has been assessed.

Study Type: Cross sectional study

Parameters Studied

Clinical parameters

Proper history regarding clinical presentation
History of Hypertension
History of Diabetes Mellitus (DM)
Trauma
Smoking and Alcohol consumption

Thorough clinical examination including measurement of blood pressure and neurological examination.

Assessment of stroke severity by Scandinavian Stroke Scale (SSS≤ 25 for severe stroke and > 25 as mild/moderate stroke) [24]

Investigational parameters

Serum fasting triglyceride level
Serum fasting total cholesterol level
Serum fasting LDL-C level
Serum fasting HDL-C level
All these measured between 12 and 36 hours after stroke onset.
CT scan of brain within 24 hours of stroke onset.

Study Tools

Each enrolled patient was meticulously examined and investigated as follows

Case No:
Name:
Age:
Sex:
Occupation:
Address:
Religion:
Relevant History:

a) Regarding presentation, Duration and Progression of illness.
b) Any past history of neurological or neuropsychiatric disorder.
c) Any preexisting cardiovascular, hematological, neoplastic or vasculitic disorder.
d) Preexisting DM, hypertension or dyslipidemia
e) Any long term drug intake

Personal History

Smoking, Alcohol or Drug addiction

Family history

- DM
- Hypertension
- Dyslipidemia

Physical examination:

Thorough physical examination including general survey and measurement of blood pressure.

Thorough neurological examination and stroke severity is assessed by Scandinavian Stroke Scale (SSS).

Laboratory investigation

- Fasting serum lipid profile measurement by semi autolyser by enzymatic method.
- -CT scan of the brain by conventional method.

Statistical Analysis

All collected data has been analyzed by appropriate statistical method. The Student *t* test was used to compare continuous variables between groups. Pearson correlation coefficient was used to analyze the independent contribution of variables statistically significant in the prediction of stroke severity. Values of $P<0.05$ were considered statistically significant.

RESULTS

Out of 150 cases studied, there were 94 (62.67%) males and 56 (37.33%) females with Male: Female ratio (M: F) of 1.68:1.

In this study, among 150 patients , 39 (26%) patients were within age group of 51 to 65. 73 (48.67%) patients were in the age group of 66 to 80. 38 (25.33%) patients were in between 81 and 95 years.

Table – 1 Correlation Between Serum Total Cholesterol and Scandinavian Stroke Scale (SSS) Score among Ischemic Stroke patients of study subjects

No. of cases (N)	Pearson's Correlation Coefficient (R)	95% Confidence Interval (CI)	p value
124	0.432	0.276 to 0.565	0.000

So, there is statistically significant positive correlation between serum Total Cholesterol and SSS Score in Ischemic Stroke patients.

Different stroke subtypes encountered in this study were classified as either ischemic stroke (IS) or intracranial hemorrhage (ICH) depending on whether it was due to infarction or hemorrhage. Out of 150 cases studied here, 124 (82.67%) cases were found to be due to IS and rest 26 (17.33%) due to ICH with a ratio of IS: ICH = 4.77:1

Table – 2 Correlation between Serum LDL Cholesterol and Scandinavian Stroke Scale (SSS) Score among Ischemic Stroke patients of study subjects

No. Of cases (N)	Pearson's Correlation Coefficient (R)	95% Confidence Interval (CI)	p value
124	0.319	0.151 to 0.469	0.000

So, there is statistically significant positive correlation between serum LDL-Cholesterol and SSS Score in Ischemic Stroke patients

Out of study sample of 150 patients, 74 (49.33%) were found to be diabetic and 76 (50.67%) were non-diabetic.

139 (92.67%) patients were hypertensive and 11 (7.33%) were non-hypertensive.

60 (40%) patients were smokers and 90 (60%) were non-smokers with a smoker: non-smoker ratio of 2:3

38 (25.33%) patients were alcoholic and 112 (74.67%) were non-alcoholic.

55 (36.67%) patients have SSS Score ≤ 25 (For stroke severity) and 95 (63.33%) have SSS Score > 25.

Table – 3 Correlation between Serum HDL Cholesterol and Scandinavian Stroke Scale (SSS) Score among Ischemic Stroke patients of study subjects

No. of cases (N)	Pearson's Correlation Coefficient (R)	95% Confidence Interval (CI)	p Value
124	0.086	-0.092 to 0.259	0.341

So, the correlation between serum HDL-Cholesterol and SSS Score in Ischemic Stroke patients is not statistically significant ($p > 0.05$).

Table – 4 Correlation between Serum Triglyceride and Scandinavian Stroke Scale (SSS) Score among Ischemic Stroke patients of study subjects

No. Of Cases (N)	Pearson's Correlation Coefficient (R)	95% Confidence Interval (CI)	P Value
124	0.809	0.738 to 0.862	0.000

So, there is statistically significant positive correlation between serum Triglyceride and SSS Score in Ischemic Stroke patients.

Table 5 Correlation Between Serum Total Cholesterol and Scandinavian Stroke Scale (SSS) Score among Intracranial Hemorrhage patients of study subjects

No. Of cases (N)	Pearson's Correlation Coefficient (r)	95% Confidence Interval (CI)	p Value
26	0.887	0.762 to 0.949	0.000

So, there is statistically significant positive correlation between serum Total Cholesterol and SSS Score in Intracranial Hemorrhage patients.

There is statistically significant positive correlation between serum Total Cholesterol and SSS Score in Ischemic Stroke patients. (r=0.432)

There is statistically significant positive correlation between serum LDL-Cholesterol and SSS Score in Ischemic Stroke patients.(r=0.319)

Correlation between serum HDL-Cholesterol and SSS Score in Ischemic Stroke patients is not statistically significant ($p > 0.05$).

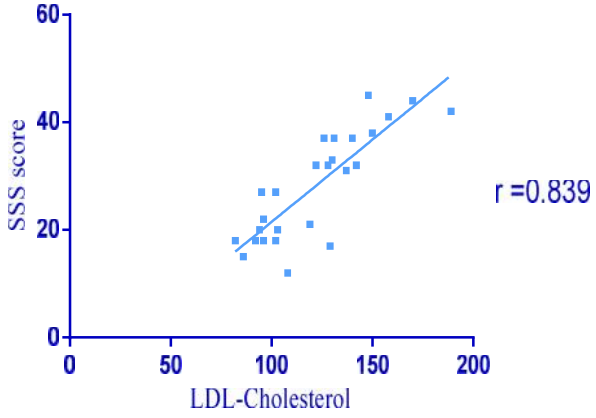
Correlation between Age and SSS Score in Ischemic Stroke patients is not statistically significant ($p > 0.05$).

There is statistically significant positive correlation between serum Triglyceride and SSS Score in Ischemic Stroke patients. (r=0.809)

There is statistically significant positive correlation between serum Total Cholesterol and SSS Score in Intracranial Hemorrhage patients. (r=0.887)

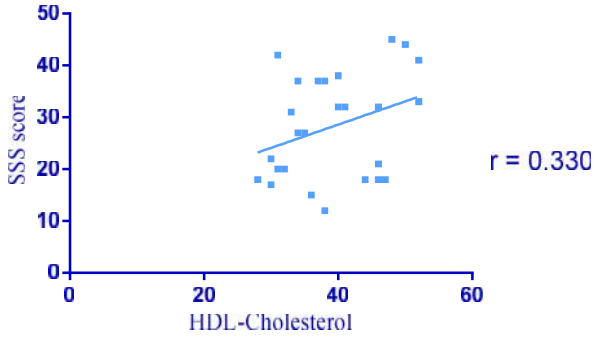
There is statistically significant positive correlation between serum LDL Cholesterol and SSS Score in Intracranial Hemorrhage patients. (r=0.839)

The correlation between serum HDL-Cholesterol and SSS Score in Intracranial Hemorrhage patients is not statistically significant ($p > 0.05$).



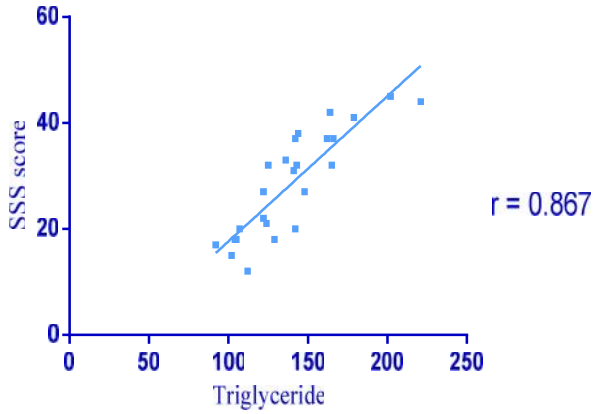
Scatter Diagram- 1. Showing correlation between Serum LDL-Cholesterol and SSS Score in Intracranial Hemorrhage cases

So, there is statistically significant positive correlation between serum LDL Cholesterol and SSS Score in Intracranial Hemorrhage patients.



Scatter Diagram- 2 Showing correlation between Serum HDL-Cholesterol and SSS Score in Intracranial Hemorrhage cases

So, the correlation between serum HDL-Cholesterol and SSS Score in Intracranial Hemorrhage patients is not statistically significant ($p > 0.05$).



Scatter Diagram- 3. Showing correlation between Serum Triglyceride and SSS Score in Intracranial Hemorrhage cases

So, there is statistically significant positive correlation between serum Triglyceride and SSS Score in Intracranial Hemorrhage patients.

The correlation between age and SSS Score in Intracranial Hemorrhage patients is not statistically significant ($p > 0.05$).

There is statistically significant positive correlation between serum Triglyceride and SSS Score in Intracranial Hemorrhage patients.(r=0.867)

DISCUSSION

We have studied total 150 patients of stroke (both ischemic stroke and intracranial hemorrhage) distributed in either sex, different age groups and associated risk factors and co-morbidities under our department during the study period (From 01.07.2014 to 31.06.2015).

In our study, there were 94(62.67%) male subjects and 56(37.33%) female subjects among the study population with a male: female ratio (M: F) of 1.68:1. The gender distribution in our study is not similar the study done by Sethi. P [81] where he has found that male: female ratio of stroke in India is 7:1. But our finding is supported by the study done by Appelros P *et al*[21] where they found age adjusted rate ratio of M: F stroke incidence in European population was 1.24:1 and for that of Australian and American population it was 1.45:1 which is closely similar to our finding.

Among 150 patients included in study, 39 (26%) patients were within age group of 51 to 65, 73 (48.67%) patients were in the age group of 66 to 80 and 38 (25.33%) were in between 81 and 95 years.

Mean age of the study population (N=150) was 72.70 +/- 10.67 years (minimum age 51 years, maximum age 93 years). Mean age of male patients (N=94) was found to be 73.52 +/- 10.5 years (minimum age 51 years, maximum age 91 years) and that of female patients (N=56) was 71.32 +/- 10.9 years (minimum age 51 years, maximum age 93 years). These findings do not match with studies conducted by Bhattcharya *et al* [22], Dalal *et al* [23] and Sridharan *et al* [24] where they found mean age of stroke onset for men in India is 63-65 years and that for women is 57-68 years. But our study results related to mean age of presentation is supported by western data where Appelros P *et al* [21] have found that mean age of first ever stroke for men vary between 60.8 and 75.3 years and for females between 65.3 and 80.4 years.

In our study, there are 124 (82.67%) cases of ischemic stroke and 26 (17.33%) cases of intracranial hemorrhage. This result is similar to that of study by Feigin *et al* [25].

Stroke severity is assessed by Scandinavian Stroke Scale (0=worst, 58=best). Higher the score, less severe is the stroke. As per the unpaired t-test serum lipid levels (TG, HDL, LDL, TCH) among diabetic and nondiabetic was found to be insignificant as well as relationship of Scandinavian Stroke Scale Score with diabetes also insignificant. Also distribution of serum lipid levels (TG, HDL, LDL,TCH) among hypertensive and non-hypertensive was found to be insignificant as well as relationship of Scandinavian Stroke Scale Score with hypertension also insignificant. But in study conducted by Jorgensen H.S *et al* [26] they found that systolic blood pressure on admission decreased relative risk of early progression and severity of stroke by 0.66 per 20 mm of Hg increase and diabetes increased relative risk of stroke progression and severity. So, our study finding in this regard does not match with them.

As per the unpaired t-test relationship of Scandinavian Stroke Scale Score with smoking is statistically insignificant. Our findings in this regard does not match with that of study performed by Weng WC *et al* [27] who have found that smoking correlated with higher stroke severity on admission for small-vessel occlusion and it was associated with lower stroke severity on admission for cardio-embolism.

Also unpaired t-test findings in our study for relationship of Scandinavian Stroke Scale Score with alcohol intake are statistically insignificant.

Observational studies have evaluated the relationship between lipids and intracranial hemorrhage (ICH) outcome. In these works an inverse association between the level of total cholesterol (TCH) and ICH has been observed,[28] relating highest mortality risks to lowest cholesterol level. The Multiple Risk Factor Intervention Trial showed higher mortality in men with ICH and TCH <160 mg/dl.[48] Moreover, low TCH and triglycerides in the first hours after ICH are strong independent predictors of in-hospital mortality,[29] and surprisingly higher cholesterol levels have been associated with better short-term outcomes after acute strokes, independently of subtype, vascular territory, age, and glycemia.[30,31] Previous observational study also support that LDL-C independently influences survival of patients with ICH; lower LDL-C levels were associated with higher mortality.[32] Our study finding is supported by these literatures. In our study, we found that there is positive correlation between serum LDL-Cholesterol (LDL-C), serum Triglyceride (TG) and serum Total Cholesterol (TCH) with Scandinavian Stroke Scale (SSS) Score in intracranial hemorrhage (ICH), which is statistically significant. So, increased levels of LDL-C, TG and TCH after acute ICH are independently associated with less severe strokes and predict favorable outcome.

Recent investigations have improved the knowledge about the pathophisiology of early hematoma growth, edema, and resultant tissue injury, factors that can cause early neurological deterioration and affect its long-term outcome. However, the relation between cholesterol levels and ICH-growth or perihematoma edema has not been specifically studied. Some authors suggest that higher cholesterol levels are associated with lesser hemorrhage growth.[33] Cholesterol is known to have effects on the vasculature and is essential for normal membrane fluidity, and adequate cholesterol levels may be important for maintaining the integrity of vessels and their resistance to rupture. [34]

In our study the correlation between serum HDL-C with SSS score is not statistically significant in both ICH and IS cases. Also the correlation between age and SSS score is not statistically significant in both ICH and IS cases and similar studies are lacking to compare these findings.

Regarding correlation of various lipid profile parameters with SSS score in ischemic stroke (IS) cases, we found that there is positive correlation between serum LDL-Cholesterol (LDL-C), serum Triglyceride (TG) and serum Total Cholesterol (TCH) with Scandinavian Stroke Scale (SSS) Score in IS, which is statistically significant. So, increase in levels of LDL-C, TG and TCH after acute IS are independently associated with less severe stroke and predict favorable outcome. Result of our study is supported by Skyhoj T. *et al*. [35] They found in their study of ischemic stroke (IS) patients that serum cholesterol was inversely and almost linearly related to stroke severity, meaning that higher cholesterol levels were associated with less severe strokes. But Weir *et al*.[36] found in their study that serum cholesterol level is not an independent predictor of stroke severity which is against our finding. Dziedzic T *et al*. [37] and Weir *et al*.[36] also found that lower level of triglyceride is associated with the more severe stroke and low triglyceride concentration strongly predicts higher mortality following stroke in ischemic stroke (IS). These studies also support our findings. We also found that higher level of LDL-C is associated with less severe stroke in IS cases which is probably because similar correlation of stroke severity with TCH.

The potential biological mechanism responsible for association between TCH, LDL-C and TG level and stroke severity in IS cases is unknown. Low TG level can reflect poor nutritional status. Although malnutrition after acute stroke is a risk factor for poor outcome,[38] it does not explain stroke severity on admission. Therefore, we believe that alternative explanations focusing on potentially neuroprotective properties of cholesterol should be considered. It was speculated that high cholesterol may be protective through increasing gamma-glutamyltransferase. This enzyme plays a role in amino acid uptake and transport and could reduce the neurotoxic effects of amino acids.[39] Cholesterol can also provide antioxidant protection.[40]

So, statistically significant inverse relationship between serum LDL-C, TG and TCH level with stroke severity on admission in both ICH and IS cases in our study are supported by existing data.

CONCLUSON

So, we have studied 150 patients presented with stroke. 94(62.67%) were male and 56 (37.33%) were female in the study population.

Mean age of the study population was 72.70 +/- 10.67 years (minimum age 51 years, maximum age 93 years). Mean age of male patients was found to be 73.52 +/- 10.5 years (minimum age 51 years, maximum age 91 years) and that of female patients was 71.32 +/- 10.9 years (minimum age 51 years, maximum age 93 years).

124 (82.67%) patients presented with ischemic stroke and rest 26 (17.33%) with intracranial hemorrhage.

Analyzing the data, it shows that neither smoking, nor alcohol intake does have any significant association with stroke severity on admission.

Alteration in serum lipid levels in stroke patients was independent of diabetic and hypertension status. Also, stroke

severity on admission has no association with diabetic and hypertension status.

Age has got no relation with stroke severity on admission.
No association could be found between serum HDL-Cholesterol and stroke severity on admission.

Serum Total Cholesterol, Triglyceride and LDL-Cholesterol levels were inversely related to stroke severity on admission, i.e. higher serum LDL

Cholesterol, Triglyceride and Total Cholesterol levels were independently associated with less severe stroke both in IS and ICH cases.

LACUNAE OF THE STUDY

In spite of every sincere effort our study has some lacunae like small sample size, self reported status of smoking and alcoholism, drug compliance for diabetes and hypertension, lack of uniformity of reports to some extents.

Another shortcoming of our study is that TG level can be affected by fasting. The patients more severely affected by stroke may have been less likely to eat after stroke onset and therefore may have had lower TG level. However, Weir *et al* [74] examined the effect of time from stroke onset on TG concentration and did not find any substantial difference between quartiles of TG concentration.

Although existing data did not show significant changes in TCH and TG concentrations during first days after stroke, we cannot exclude that acute phase reaction accompanying stroke can at some degree influence TCH and TG level.

However we have tried to exclude confounding factors as far as possible.

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