STUDY OF ELECTROLYTES AND LIVER FUNCTION TESTS IN CHRONIC ALCOHOLISM

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ABSTRACT

Objective: Alcohol abuse is considered one of the major health issue in India, which can impair the electrolyte balance in chronic patient of alcoholism. In the present study, investigation has been conducted to estimate the levels of calcium, magnesium, SGOT, SGPT, total protein and urea in the chronic alcoholic patients and their comparison was determined with normal healthy controls.

Methods: A total of 50 male alcoholics consuming variable amount of alcohol from more than past 5 years in the age frame of 30–70 years were taken. Equal number of age-matched normal healthy individuals without the family history of any disease served as controls. Levels of magnesium (Mg), calcium (Ca), and other biochemicals, namely urea and total protein, transaminases, namely serum glutamate oxaloacetate transaminase and serum glutamate pyruvic transaminase were estimated colorimetrically in all the subjects consuming variable amount of alcohol.

Results: Alcoholics were found to have lower magnesium, calcium, and total protein levels as compared to non-alcoholics, whereas transaminases were higher in alcoholics, predicting hepatocytes injury. Catalytic activity of alcohol dehydrogenase produced highly reactive acetaldehyde forming adducts with membrane proteins, leading to organ damage. Alcohol disturbed the electrolytes balance produced hypomagnesia and hypocalcemia and severely affected liver function tests.

Conclusion: Magnesium levels and other related parameters could be considered as diagnostic predictors of alcohol-related toxicity. Age advances the alcohol-related health consequences, and this could be due to the cumulative effect of reduced intestinal absorption, dietary deficiencies, and alcohol toxicity.

Keywords: Alcoholism, Magnesium, Transaminases, Liver, Calcium, Total proteins.

INTRODUCTION

Alcoholism is the most serious health problem in India and is seen in all socioeconomic and ethnic groups. Excessive alcoholism leads to impaired control over drinking which results in health and social problems. Chronic alcoholism as defined by the WHO relates to those drinkers who are in the habit of drinking about 75 ml of pure ethanol or 200 ml or more of 40–60% of alcohol, for example, whisky, brandy, rum, gin, or country liquor daily for the past 5 year [1]. Alcohol is the third leading cause of preventable death in India after smoking and obesity and is responsible for large number of deaths, homicides, suicides, and motor vehicle accidents [2]. There is a high risk for multiple organ failures due to chronic alcoholism as it leads to micronutrient deficiency and toxicity in all the body tissues [3].

Alcohol is primarily a central nervous system depressant and the degree of depression produced is directly related to the amount consumed. The effects are in the form of euphoria, loss of social serves, ataxia, drowsiness, coma, deep coma, and finally death. Ethanol is miscible and permeates all tissues in the body, and leads to the harmful effects on a large number of organs including the nervous system, liver, pancreas, gastrointestinal tract, heart, endocrinal gland, hematopoietic system, and bones. Furthermore, since it does not require to be digested but is taken up unchanged from the stomach to the bloodstream, hence, it is a rapid source of energy. Consuming alcohol excessively causes malnutrition as it disturbs the balance among carbohydrates, proteins, and fats, thereby leading to deleterious consequences. Alcohol causes gastritis, which lessens the stomach's ability to absorb nutrients from the body, interferes with the utilization at the cellular level. Alcohol intake in excess increases the need for certain nutrients essential for its breakdown, thus exacerbating any existing deficiency.

The oxidation of alcohol in the human body is carried out predominantly in the liver. Tetrahydroisoquinoline is a highly addictive substance resembling morphine, builds up in the brain of chronic alcoholics [3]. Chronic alcoholism leads to the formation of fatty liver and occurrence of toxicity due to the accumulation of acetaldehyde by the enzyme alcohol dehydrogenase. The acetaldehyde is converted further to acetate by aldehyde dehydrogenase, then to acetyl coenzyme A, which is oxidized to carbon dioxide and water or converted to other biochemically important compounds including fatty acids by citric acid cycle. Alcohol is metabolized by microsomal ethanol oxidizing system. Malnourishment and vitamin deficiencies are generally associated with chronic alcoholic cases. Electrolyte disturbances also occur and are related to higher incidence of arrhythmias [4]. Ethanol leads to the dearrangement of monovalent and divalent cation metabolism and acid-base homeostasis in the body [5]. Chronic alcohol abuse can result in various liver injuries that range from mild fatty infiltration to cirrhosis and hepatocellular carcinoma [6]. In our study, we have investigated the levels of serum magnesium and calcium along with biochemical parameters related to liver cell injury in chronic alcoholic patients with the incidence of liver dysfunction.

METHODS

The current investigation was conducted in the Department of Biochemistry, Guru Nanak Dev Hospital, Amritsar. 50 known male alcoholics consuming variable amount of alcohol from more than past 5 years in the age range of 30–70 years were selected as patients. Equal number of age-matched normal healthy individuals from same population and without any present or previous disease or without any family history of disease was selected to serve as control groups. Inclusion criteria involved the alcohol consumption of more than past 5 years and specified age. Exclusion criteria involved patients already diagnosed with liver and pancreatic diseases and alcoholics under treatment. The proposed protocol was ethically approved by the institutional ethical committee. Approximately 3 ml of blood sample was collected from each patient and serum was separated by centrifugation at 3000 rpm for 15 min and used for further analysis. Serum magnesium and calcium levels were determined colorimetrically by calmagite method and OCPC method, respectively. Total proteins were estimated by Biuret method and levels of urea were estimated by Bertholet method. The activities of serum transaminases (serum glutamate oxaloacetate transaminase [SGOT] and serum glutamate pyruvic transaminase [SGPT]) were also determined colorimetrically.

RESULTS AND DISCUSSION

A total of 50 chronic alcoholic patients were studied for determining the levels of serum magnesium, calcium, and other biochemical parameters of liver cell injury, namely SGOT, SGPT, total proteins, and urea and were compared with the normal controls. It has been observed that the alcoholics were found to have lower magnesium and calcium level as compared to the normal healthy individuals and were also found to be affected by the age of the subject and volume of alcohol consumed per day (Tables 1-3).

Average serum magnesium level in alcoholic subjects was found to be 1.64±0.30 mg/dl comparative to 2.33± 0.37 mg/dl in control subjects which indicates that the excesssive consumption of alcohol have significant role in reducing the serum magnesium level. Further, It was also observed that there is significant reduction in serum calcium level in alcoholic subjects comparative to control groups as shown in Table 1 These findings were similar to those of Mendelson *et al.* [7]

and Randall *et al.* [8]. Reduced secretion of PTH in alcoholism causes the enhanced fractional excretion of magnesium [9].

Subjects under study were also grouped on the basis of age as given in Table 2. It has been seen that both magnesium and calcium levels were also found to be affected with age since they got further diminished as the age increases. Age advances alcohol-related hypomagnesemia which could be due to the cumulative effect of multiple factors such as dietary deficiency, reduced intestinal absorption, and increased sensitivity to alcohol-related toxicity [10,11].

Serum magnesium and calcium level was found to be 1.68±0.35 mg/dl and 7.83±1.07 mg/dl, respectively, in the alcoholic subjects of age group of 30–45 years which indicated the significant relation between electrolyte balance and alcohol consumption. Magnesium and calcium levels were found comparatively higher in control group of same age group. Similar patterns were observed in other age groups although the levels were reduced in patients as the age increases and minimum levels were observed in the alcoholic subjects with the age of >60 years. Low serum magnesium levels in alcoholics diminished the sensitivity of parathyroid gland to low serum calcium levels due to which gland fails to secrete hormone in sufficient amount when the serum calcium levels drop. The low serum calcium levels in alcoholics are either due to reduced intake or due to inadequate absorption due to Vitamin D deficiency as it is necessary for adequate absorption of calcium from the gut. Malabsorption, which is common in alcoholics, resulted in poor absorption of Vitamin D and other fat-soluble vitamins. In the intestine, unabsorbed fats form insoluble soaps with calcium, which further decreased the amount of available calcium [12].

The alcoholic subjects in the present investigation were also categorized into three groups on the basis of alcohol consumed in a day as given in Table 3. In subjects consuming 60–200 ml of alcohol in a day (n=17), serum magnesium levels were found with mean±S.D of 2.58±0.28 mg/dl and calcium levels with a mean±S.D of 8.3±0.90 mg/dl. In subjects consuming 200–300 ml in a day (n=18), magnesium levels were found with mean±S.D of 2.35±0.35 mg/dl and calcium levels with a mean±S.D of 8.20±0.98 mg/dl. Very low levels of both magnesium and calcium were found in subjects consuming 300 ml alcohol on daily basis (n=17), serum magnesium levels with mean±S.D of 1.65±0.27 mg/dl,

Table 1: Levels of serum magnesium and calcium in alcoholics and non-alcoholics

Group	Number of cases (n)	Serum magnesium		Serum calcium	
		Range (mg/dl)	Mean±SD	Range (mg/dl)	Mean±SD
Non-alcoholics (Control)	50	1.8-3.0	2.33±0.37	8.0-11.5	9.41±0.95
Alcoholics (Subject)	50	1.1-2.4	1.64±0.30	7.6-10.3	8.11±0.93

Table 2: Comparison of serum magnesium and calcium levels in alcoholics and non-alcoholics of different age groups

Age (years)	Non-alcoholics			Alcoholics		
	Number of Cases (n)	Serum Mg level (mg/dl)	Serum Ca level (mg/dl)	Number of Cases (n)	Serum Mg level (mg/dl)	Serum Ca level (mg/dl)
Group-I (30–45)	22	2.1±0.38	9.35±0.87	23	1.68±0.35	7.83±1.07
Group-II (46–60)	22	2.1±0.38	9.38±1.03	16	1.65±0.32	7.62±0.94
Group-III (>60)	6	2.0±0.36	9.68±1.07	11	1.61±0.24	7.55±0.51

Table 3: Effect of variable amount of alcohol consumption on magnesium and calcium levels in blood serum

Alcohol Consumed (ml)	Number of cases (n)	Serum Mg Level		Serum Ca Level	
		Range (mg/dl)	Mean±SD	Range (mg/dl)	Mean±SD
60–200	17	1.2-2.1	2.58±0.28	7.9–9.8	8.3±0.90
200–300	18	1.1-2.4	2.35±0.35	7.7–10.3	8.2±0.98
300 and above	15	1.1-2.1	1.65±0.27	7.6–10.0	7.86±0.89

Table 4: Levels of transaminases, total proteins, and blood urea in non-alcoholics and alcoholics

Groups	Number of cases (n)	SGPT (IU/L)	SGOT (IU/L)	Total protein (g/dl)	Blood urea (mg/dl)
Non-alcoholics (Control)	50	29.30±8.45	31.69±8.24	6.92±0.85	31.46±6.60
Alcoholics (Subject)	50	61.96±15.47	52.57±15.73	5.95±0.71	32.20±7.2

SGOT: Serum glutamate oxaloacetate transaminase, SGPT: Serum glutamate pyruvic transaminase

and calcium levels with a mean±S.D of 7.86±0.89 mg/dl. It has been inferred that increased alcohol consumption diminishes the levels of both magnesium and calcium. Alcohol acts as a diuretic, which increases the magnesium excretion with increased alcohol ingestion, which might be due to decreased renal sensitivity to vasopressin. The prolonged consumption of large volumes of hypotonic fluids scaled down medullary intestinal osmolarity, which consequently reduced the concentrating ability of renal medulla. Patients with chronic alcoholism have large number of renal tubular abnormalities that are independent of chronic liver disease, pancreatitis and that also occurs in the presence of normal glomerular filtration. Ethanol directly also inhibits the Na/K ATPase pump of proximal tubular cells, thereby inhibits the reabsorption of calcium resulting in enhanced urinary excretion of calcium and all such factors ultimately resulted in hypocalcemia in alcoholics [13].

The difference between the levels of liver parameters between control group and subjects has been found to be significant (Table 4). The levels of transaminases, namely SGOT and SGPT were markedly elevated in alcoholic subjects as compared to the normal controls. The raised SGOT and SGPT levels are the predictors of underlying cell injury. The liver parenchymal cells are sensitive to alcohol. Acetaldehyde resulting from the catalytic activity of alcohol dehydrogenase is highly reactive and is capable of making adducts with proteins and nucleic acids. This adduct formation with membrane protein is the first step in liver cell injury. Besides leakage of these enzymes into the circulation due to necrosis of hepatocytes, these enzymes are also induced (especially SGOT) by the presence of alcohol [14]. Total proteins present in the blood serum have also been reduced under the effect of alcohol; however, blood urea concentration was found to be marginally higher in alcoholics as compared to controls. The toxic effects of alcohol on liver function were further confirmed by the fall in serum total protein levels among alcoholics in comparison to the normal healthy individuals which could be due to decrease in the synthetic function of liver and slower rate of protein catabolism in alcoholics [15].

CONCLUSION

Hypomagnesemia and hypocalcemia among alcoholics can shorten the lifespan if left untreated. There is a need to recognize the hidden alcoholics and to give attention to alcohol-related complications. Serum magnesium and calcium estimation being simple and reliable parameter can be used as a therapeutic, diagnostic, and prognostic factor in the chronic as well as hidden alcoholics. Better awareness of magnesium and calcium deficiencies in chronic alcoholics can guide in imparting lifesaving treatment and lesson morbidity in such patients.

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