Section: General Medicine

Original Research Article

CLINICAL SIGNIFICANCE OF SERUM SODIUM LEVELS IN LIVER CIRRHOSIS: A CROSS-SECTIONAL OBSERVATIONAL STUDY

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Received : 21/08/2024
Received in revised form : 12/10/2024
Accepted : 27/10/2024

Keywords:
Cirrhosis, Hyponatremia, Child-Pugh score, Serum sodium, Liver disease, Complications.

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DOI: 10.47009/jamp.2024.6.5.120

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2024; 6 (5); 636-640

Abstract

Background: Cirrhosis with portal hypertension causes hypervolemic hyponatremia due to altered sodium and water homeostasis, which increases the risk of complications and mortality. However, the link between serum sodium levels and the severity of cirrhosis remains unclear. This study evaluated the correlation between serum sodium levels and the severity and complications of liver cirrhosis, using the Child-Pugh score as a marker for disease severity. **Materials and Methods:** This cross-sectional observational study included 50 patients diagnosed with liver cirrhosis who were admitted to Trichy SRM Medical College Hospital. Serum sodium levels were measured upon admission and correlated with the Child-Pugh score and complications, such as ascites, hepatorenal syndrome, and hepatic encephalopathy. **Result:** The majority were aged 41-50 years (46%), with a significant male predominance (96%). Lifestyle factors included 52% smokers and 94% patients with a history of alcohol use. Hyponatremia (serum sodium <130 mEq/L) was present in 34% of the patients, while 66% had sodium levels above 131 mEq/L. Complications were common, with ascites affecting 52% and hepatic encephalopathy affecting 38%. In Child-Pugh Class A, 5.9% of hyponatremic patients had sodium levels below 130 mEq/L, whereas 3.0% had sodium levels above 131 mEq/L. In Class B, 11.8% of patients had hyponatremia compared to 36.4% with normal sodium levels. The most notable difference was in Class C, where 82.4% had hyponatremia and 60.6% had normal sodium levels. A p-value <0.0001 indicated a significant difference across the Child-Pugh classes. **Conclusion:** This study emphasizes that Monitoring serum sodium levels is crucial in liver cirrhosis because hyponatremia is associated with advanced disease and higher complication rates, suggesting that early intervention may improve patient outcomes.

INTRODUCTION

Cirrhosis with portal hypertension is a major contributing factor to hypervolemic hyponatremia, a common electrolyte disturbance in patients with chronic liver disease.[1] Hyponatremia in cirrhosis arises due to compromised effective central blood volume, triggered by reflex splanchnic vasodilation, which activates compensatory mechanisms such as vasoconstriction and anti-natriuretic processes.[2] These lead to an imbalance where free water retention exceeds sodium retention, resulting in dilutional hyponatremia.[3] This condition is relatively common, occurring in approximately 50% of hospitalized patients with cirrhosis and 40% of cirrhotic outpatients.[4]

The coexistence of hyponatremia in cirrhosis is clinically significant and associated with a higher Child-Pugh score, massive ascites, hepatorenal syndrome, hepatic encephalopathy, and spontaneous bacterial peritonitis. Hyponatremia is associated with increased mortality in cirrhotic patients when compared to those with normal serum sodium levels.[5-7] Recent research indicates that hyponatremia is a significant predictive factor in chronic liver disease. Additionally, patients with hyponatremia have poorer survival rates compared to those without it.8 While there has been substantial research on the role of serum sodium levels in the progression of severe liver disease, results have been

ISSN (O): 2687-5365; ISSN (P): 2753-6556

variable. There remains limited data correlating serum sodium levels with the development of cirrhosis complications.

This study aimed to explore the relationship between serum sodium levels and liver cirrhosis, in terms of disease severity and complications. Specifically, this study aimed to determine the association between serum sodium levels and liver cirrhosis severity. Furthermore, we investigated the correlation between hyponatremia and the development of cirrhotic complications.

Raj et al. (2022) conducted a study to determine the association between serum sodium levels and the severity and complications of liver cirrhosis. Ninety-five patients were enrolled in the study. The majority of participants were in the age group of 41-50 years (35.8%), with a mean age of 48.38±11.8 (mean±SD). Male patients were predominant (91 patients, 96.8%). Hyponatremia (≤130 mEq/L) was observed in 33 (34.7%) patients. Among patients with hyponatremia, 29 (87.9%) were classified as Child-Pugh C. The association between hyponatremia and Child-Pugh C was significant (OR, 3.987; CI 1.240-12.818; p=0.029). A positive correlation was identified between low sodium levels (≤130 meq/L) and complications such as spontaneous bacterial peritonitis (OR 4.667; CI 1.538-14.164; p=0.004) and hepatorenal syndrome (OR 5.357; CI 0.979-29.327; p=0.034). The study concluded low sodium levels in cirrhosis demonstrate a positive correlation with disease severity, hepatorenal syndrome, and spontaneous bacterial peritonitis.[1]

Chaudhary et al. (2022) conducted a study that investigated serum sodium levels in patients with chronic liver disease (CLD) patients and established their association with disease severity. Patients were categorized based on their serum sodium levels: Group A (<130 mEq/l), Group B (131-135 mEq/l), and Group C (≥136 mEq/l). Hepatic encephalopathy (p<0.01), hepatorenal syndrome (p<0.01), and coagulopathy (p<0.01) occurred significantly more frequently among patients in Group A compared to those in Groups B or C. The mean MELD score, CPS score, and mortality rate were significantly higher among Group A patients. Patients with lower serum sodium levels had substantially higher MELD and CPS scores. Low serum sodium levels are associated with more severe liver diseases, increased complications, and higher mortality rates. The study recommends frequent monitoring of serum sodium levels in patients with chronic liver disease.[8]

Singh et al. (2022) conducted a study to investigate the association between altered serum sodium levels and disease severity (as measured by Child-Pugh Score [CPS] and Model for End-Stage Liver Disease [MELD]) and to evaluate the types of dysnatremias commonly observed in chronic liver disease (CLD) and their association with CLD complications. Among the 120 patients with CLD, 30.8% exhibited serum sodium levels ≤130 mEq/L, 32.5% had levels between 131 and 135 mEq/L, and 36.7% had levels ≥136 mEq/L. Thus, hyponatremia was observed in 63.3% of patients. The mean MELD score and CPS were significantly higher in patients with reduced serum sodium levels. Furthermore, Child-Pugh Class C was significantly more prevalent in patients with serum sodium levels ≤130 mEq/L than in other patients. Hepatic encephalopathy, hepatorenal syndrome, and coagulopathy occurred significantly more frequently in patients with serum sodium levels ≤130 mEq/L. The study concluded that hyponatremia was highly prevalent among patients with CLD. Low serum sodium levels are associated with more severe liver diseases, increased complications, and higher mortality rates.[9]

Janičko et al. (2023) conducted a systematic review of the clinical significance and management of hyponatremia in patients with liver cirrhosis. The study highlighted that hyponatremia is prevalent in approximately 50% of cirrhotic patients, with hypovolemic hyponatremia often resulting from diuretic treatment or gastrointestinal losses, whereas hypervolemic hyponatremia is due to mechanisms such as water and sodium retention. The review indicated that hyponatremia is a strong predictor of mortality and is associated with increased risks of conditions such as hepatorenal syndrome (OR 4.667, CI 1.538–14.164), neurological disturbances, and adverse post-liver transplant outcomes. Treatment recommendations include addressing underlying causes, fluid restriction, albumin infusions, and selective pharmacological approaches.[3]

Islam et al. (2023) conducted a study to investigate the association between serum sodium and 24-hour urinary sodium levels with various grades of ascites and its complications in cirrhotic patients. The study included 96 patients with cirrhotic ascites, of whom 48 presented with mild, moderate, and severe ascites, while the remaining 48 patients exhibited ascites complications, such as refractory ascites, spontaneous bacterial peritonitis, and hepatorenal syndrome. The mean serum sodium levels were 131.69 ± 4.90 and 124.88 ± 5.67 mmol/L, and the 24-hour urinary sodium levels were 76.82 ± 45.64 and 35.26 ± 22.57 mmol/L in the uncomplicated and complicated ascites groups, respectively, with P value < .001. A significant association (p = .001) was observed between mean serum sodium (mmol/L) level (R −0.777) and 24-hour urine sodium (mmol/L) level (R −0.704) in grade 1, grade 2, and grade 3 ascites; however, no significant difference was noted when considering refractory ascites, spontaneous bacterial peritonitis, and hepatorenal syndrome. The findings indicated that low serum sodium and low 24-hour urinary sodium levels were associated with the development of severe complications of cirrhotic ascites. Serum sodium and 24-hour urinary sodium levels may serve as effective predictors for grading and complications of cirrhotic ascites.[10]

ISSN (O): 2687-5365; ISSN (P): 2753-6556

MATERIALS AND METHODS

This cross-sectional observational study included 50 patients with liver cirrhosis admitted to the Trichy SRM Medical College Hospital. This study was approved by the Institutional Ethics Committee before initiation, and informed consent was obtained from all patients.

Inclusion Criteria

Patients aged 18 years and older and those clinically diagnosed with liver cirrhosis based on clinical features, laboratory investigations, and imaging findings. Only patients with a stable hemodynamic status upon admission were included in the study.

Exclusion Criteria

Exclusion criteria included patients with heart failure, chronic kidney disease, those on thiazide diuretics, pregnant women, and patients with severe non-hepatic comorbidities (such as active malignancies or sepsis).

Methods: The diagnosis of liver cirrhosis was based on a combination of clinical features (jaundice, ascites, and signs of portal hypertension), liver function tests (e.g., hyperbilirubinemia, hypoalbuminemia, and prolonged prothrombin time), and ultrasonographic findings (e.g., shrunken liver and surface nodularity). Upon admission, patients' serum sodium levels were measured and correlated with their Child-Pugh score to assess the severity of liver disease. Additionally, the presence of cirrhotic complications such as ascites, hepatorenal syndrome, and hepatic encephalopathy was recorded.

Statistical analysis: Data were analyzed using SPSS IBM version 26.0. Continuous variables (e.g., age) were assessed for normality, and descriptive measures such as mean, standard deviation, and range were calculated for the normally distributed data. Comparisons between subgroups were performed using t-tests or one-way ANOVA as appropriate. Categorical data are presented as frequency and percentage values, and comparisons were tested using the paired t-test. Statistical significance was set at $p < 0.05$.

RESULTS

Fifty patients were included in this cross-sectional observational study that examined the clinical significance of serum sodium levels in liver cirrhosis. The age distribution showed that most patients were between 41-50 years old (46%), followed by 24% below 40 years, 14% between 51-60 years, and 16% above 61 years. There was a significant male predominance, with 96% of the cohort being male and only 4% being female.

Regarding lifestyle factors, 52% of the patients were smokers and 94% had a history of alcohol use. Hepatitis B infection was identified in 6% of patients. Hyponatremia (serum sodium <130 mEq/L) was present in 34% of patients, while 66% had serum sodium levels above 131 mEq/L [Table 1].

Complications associated with liver cirrhosis are common. Ascites were the most frequent complication, affecting 52% of patients. Hepatic encephalopathy was present in 38% of the patients, variceal bleeding in 30%, spontaneous bacterial peritonitis in 18%, and hepatorenal syndrome in 8%. Child-Pugh scores indicated that 66% of patients were in class C, 30% in class B, and only 4% in class A [Table 2].

In Child-Pugh Class A, 5.9% of patients with hyponatremia had a sodium level < 130 mEq/L, whereas 3.0% had levels above 131 mEq/L. In Class B, 11.8% of the patients with hyponatremia fell into this category, whereas 36.4% of the patients with sodium levels above 131 mEq/L were classified. The most striking difference was observed in Class C, where 82.4% of patients with hyponatremia were classified, compared with 60.6% of patients with normal sodium levels. A p-value <0.0001 across the Child-Pugh class indicates a significant difference [Table 3].

Table 1: Demographic and Lifestyle Characteristics of the Patients.

		Number of Patients	Percentage
Age	<40	12	24%
	41-50	23	46%
	51-60	7	14%
	>61	8	16%
Gender	Male	48	96%
	Female	2	4%
Smoking	Yes	26	52%
	No	24	48%
Alcohol	Yes	47	94%
	No	3	6%
Hepatitis B	Yes	3	6%
	No	47	94%
Hyponatremia	<130	17	34%
	>131	33	66%

Table 2: Frequency of Complications and Child-Pugh Score of the Patients

		Number of Patients	Percentage
Complication	Ascites	26	52%
	Hepatic encephalopathy	19	38%
	Variceal bleed	15	30%
	Hepatorenal syndrome	4	8%

ISSN (O): 2687-5365; ISSN (P): 2753-6556

	Spontaneous bacterial peritonitis	9	18%
Child-Pugh Score	A	2	4%
	B	15	30%
	C	33	66%

Table 3: Child-Pugh Score and Hyponatremia Correlation

Child-Pugh Score	Hyponatremia		P value
	<130 (n=17)	>131 (n=33)	
A	1 (5.9%)	1 (3%)	<0.0001
B	2 (11.8%)	12 (36.4%)	
C	14 (82.4%)	20 (60.6%)	

DISCUSSION

Liver cirrhosis is a significant global health concern, often complicated by various clinical manifestations, such as hyponatremia, ascites, hepatic encephalopathy, and variceal bleeding. This study provides important insights into the correlation between serum sodium levels and liver cirrhosis severity. The majority were aged 41-50 years (46%), with a significant male predominance (96%). In line with our findings, Nareddy et al. found that most patients were aged 41-50 years (35.8%), with a male predominance (96.8%).4 Similarly, Raj and Mehta observed that the majority of patients were aged 41-50 years (35.8%) with a male preponderance (96.8%).[1]

In our study, 34% of patients had hyponatremia (serum sodium <130 mEq/L), which is consistent with previous studies linking low sodium levels to poor prognosis in patients with cirrhosis. Nareddy et al. and Raj and Mehta both reported that the prevalence of hyponatremia was 34.7%, which is comparable to the current study.[1,4] However, Singh et al noted a very high prevalence of hyponatremia (63.3%) compared to the current study.[9] The high prevalence of hyponatremia in this cohort aligns with the known pathophysiology of cirrhosis, wherein impaired renal water excretion due to hypersecretion of antidiuretic hormone results in dilutional hyponatremia.

In our study, the distribution of complications further highlights the disease burden in patients with advanced cirrhosis. Ascites, found in 52% of the patients, were the most common complication, reflecting the decompensated state of cirrhosis. Similarly, hepatic encephalopathy was observed in 38% of the patients, which is indicative of both hepatic and neurocognitive deterioration. The presence of spontaneous bacterial peritonitis (18%) and hepatorenal syndrome (8%) underlines the multisystemic nature of advanced cirrhosis and its association with high morbidity. Goyal et al. determined that hyponatremia (sodium levels <125 mEq/L) is associated with severe complications such as ascites, coagulopathy, spontaneous bacterial peritonitis, and hepatorenal syndrome.[11]

We found that hepatitis B infection was present in 6% of patients. Islam et al. noted that hepatitis B virus accounted for 57% of cases, followed by hepatitis C virus (18%) and other causes (21%).10 In developing countries, hepatitis B is the leading cause of cirrhosis, followed by hepatitis C and non-alcoholic steatohepatitis (NASH).[12] Levesque et al. reported that hepatitis B virus and hepatitis C virus were responsible for 4% and 14% of cirrhosis cases, respectively.[13]

In our study, the Child-Pugh score, an established tool for assessing cirrhosis severity, showed that the majority of patients (66%) were in class C, indicating severe liver dysfunction. Our study demonstrated a clear correlation between increasing severity of liver disease and hyponatremia. Patients with Child-Pugh Class C showed a significantly higher incidence of hyponatremia, emphasizing that more severe liver dysfunction is associated with lower sodium levels.

Angeli et al. studied 997 patients across 28 centres and observed that the prevalence of low sodium levels was 49.4% (≤135 mmol/L), 21.6% (≤130 mmol/L), 5.7% (≤125 mmol/L), and 1.2% (≤120 mmol/L). Low sodium levels were correlated to severe ascites, renal impairment, and higher rates of hepatic encephalopathy, spontaneous bacterial peritonitis, and hepatorenal syndrome, especially at levels <130 mmol/L.7 Nareddy et al observed that 87.9% of patients with hyponatremia were classified as Child-Pugh Class C and low sodium levels positively correlated with complications like spontaneous bacterial peritonitis and hepatorenal syndrome (p=0.034).[4]

Chaudhary et al. found that hepatic encephalopathy, hepatorenal syndrome, and coagulopathy were significantly more common in patients with sodium levels of <130 mEq/L. These patients also exhibited higher Child-Pugh scores and increased mortality.8 Singh et al. found that patients with serum sodium levels ≤130 mEq/L had significantly higher Child-Pugh scores and a greater prevalence of hepatic encephalopathy, hepatorenal syndrome, and coagulopathy compared to others.[9] Porcel et al. reported that the incidence of hepatorenal syndrome and mortality was higher in patients who spontaneously developed hyponatremia.[14]

Additionally, Islam et al. demonstrated that low sodium levels are linked to severe complications of cirrhotic ascites and serve as a reliable predictor for grading and complications of the condition.[10] Hyponatremia is an independent predictive factor for survival in patients with acute-on-chronic liver failure.[15] Therefore, assessing serum sodium levels in liver disease patients could enhance patient prioritization

ISSN (O): 2687-5365; ISSN (P): 2753-6556

CONCLUSION

This study highlights the clinical significance of serum sodium levels in patients with liver cirrhosis and demonstrates a clear association between hyponatremia and advanced disease. The high prevalence of complications in patients with low serum sodium levels, coupled with their correlation with higher Child-Pugh scores, reinforces the value of monitoring sodium levels as a simple yet effective prognostic tool. Early identification and management of hyponatremia may help mitigate some severe complications of cirrhosis and improve patient outcomes.

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ISSN (O): 2687-5365; ISSN (P): 2753-6556