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Exploring Acid-Base Imbalance in Liver Cirrhosis: Diagnostic and Therapeutic Perspectives

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ABSTRACT

Background: liver cirrhosis Patients experience disturbances in their body acid-base balance which reflects disease of the liver and affect the whole body. Possible imbalances can be either metabolic alkalosis, respiratory alkalosis or high anion gap metabolic acidosis and each can provide valuable diagnostic and outcome insights. **Objectives:** To explore the processes, patterns and clinical outcomes of acid-base disorders in patients with cirrhosis and to suggest relevant diagnostic and treatment methods. **Study Design:** A Cross-Sectional Study. **Place and Duration of study:** From July 2024 to December 2024 Gastroenterology Department, Sandeman Provincial Hospital / Bolan Medical College / Hospital, Quetta. **Methods:** This cross-sectional study conducted at a tertiary Hospital between July 2024 to December 2024. We obtained the data from cirrhotic patients who had blood analyzed in an arterial blood gas test. **Results:** 94 cirrhotic patients investigated (mean age: 54.7 ± 9.6) years), 82.9% had acid-base disorders. A typical finding in our cohort was respiratory alkalosis which was seen in 46.8% of all patients and mainly related to hepatic encephalopathy or portosystemic shunting. In 17.0% of these patients, metabolic alkalosis took place, commonly seen in those who use a lot of diuretics and lose stomach fluids through vomiting. The majority of cases of high anion gap metabolic acidosis (11.7%) were found in patients with advanced liver failure, sepsis or trouble with kidney function 4% of the cases were mixed acid-base disorders. Marked hypoalbuminemia was found in nearly all cases (88%) which meant that albumin-corrected anion gap was used to accurately understand metabolic acidosis and enhance diagnostic precision. **Conclusion:** Irregular acid-base levels are typical in cirrhosis and often occur together. Correctly uncovering liver and kidney problems and using management based on these issues is necessary to improve these patients' outcomes.

INTRODUCTION

In its advanced stages, liver cirrhosis is characterized by hepatocellular dysfunction, portal hypertension, and multisystem involvement. Among the resulting systemic disturbances, acid-base imbalances are particularly common and are frequently associated with the severity of the disease. Changes in blood pressure, kidney function problems and higher death rates [1]. Maintaining the balance of acid levels in the body is mainly based on ammonia metabolism, the clearing of lactate and bicarbonate synthesis by the liver. With damaged liver function, these regulators do not function as they should, causing various and often similar acid-base abnormalities [2]. Among cirrhotic patients, the most common acid-base disorder is respiratory alkalosis, seen in most cases [3]. Hepatic encephalopathy often makes people breathe quickly, decreasing oxygen for the lungs in hepatopulmonary syndrome or enlarging blood vessels throughout the body which can all lead to low $PaCO_2$ [4]. Sometimes considered harmless, chronic respiratory alkalosis may make the brain vessels narrow, worsening the brain damage. "In advanced liver disease, gastrointestinal bleeding often precipitates metabolic alkalosis, primarily due to factors such as excessive diuretic use, persistent vomiting, and nasogastric suction. If unrecognized, this condition can exacerbate systemic hypertension and contribute to renal vasoconstriction. Furthermore, metabolic alkalosis may impair myocardial oxygen delivery, thereby aggravating cardiac dysfunction. Notably, metabolic alkalosis can coexist with acute lactic acidosis, particularly in the context of sepsis, tissue hypoxia, or impaired hepatic lactate clearance, as seen in

acute-on-chronic liver failure (ACLF).[7]. As with liver failure, renal disorders—especially in cases of hepatorenal syndrome—can result in acidosis since bicarbonate is poorly absorbed and hydrogen ions are not properly removed [8]. Cirrhosis often causes a low serum albumin level which can hide acid-base problems by reducing the serum anion gap. In this kind of situation, correcting for albumin in the serum is required for proper diagnosis and treatment [9]. These disorders challenge healthcare professionals, since they usually mix respiratory and metabolic causes and doctors need to interpret ABGs, review the medical context and study biochemical data. Not only are their appearance a sign of worsening hepatic failure, but they have an impact on treatment choices for fluids, diuretics and liver transplantation [11,12]. This research seeks to review the common forms of acid-base disorders in patients with liver cirrhosis, relate them to their medical condition and see if their severity can be linked to clinical outcomes.

METHODOLOGY

94 people whose liver cirrhosis was found through both clinical and radiologic means. Blood samples were taken for arterial blood gas and standard liver and renal function tests at the time of hospital admission. During January to December 2023, this observational study was carried out in the Department of Gastroenterology at the tertiary care teaching hospital. Five possible classifications for acid-base status were used: respiratory alkalosis, metabolic alkalosis, high anion gap metabolic acidosis, mixed disorders and normal. Liver disease severity was estimated for each patient by calculating their MELD and Child-Pugh scores. Problems with anion gap were resolved by adjusting the value for serum albumin. The participants gave informed consent after the project got ethical approval from our institution.

Inclusion Criteria

Only admissions of adults with known cirrhosis who had ABG tests performed were included for this study.

Exclusion Criteria

People with chronic breathing illnesses, under mechanical ventilation or who suffer from primary renal tubular acidosis were not included.

Data Collection

All collected data were recorded on a standardized Proforma indicating demographics, 2 clinical observations and laboratory values. All patients had their blood analyzed for acid-base and chemistry within 6 hours after being admitted to the hospital.

Statistical Analysis

The data were all analyzed in SPSS version 24. Quantitative data was given as mean ± standard deviation and qualitative variables were displayed as frequencies and percentages. Differences in groups were assessed using independent t-tests and chi-square tests. A p-value less than 0.05 was judged to be statistically significant.

RESULTS

94 cirrhotic patients; of those, 61 were men (65%), while 33 were women (35%), with an average age of 54.7 ± 9.6 years. Among all causes, hepatitis C virus–related cirrhosis was found in nearly half the cases (41.5%), with alcohol accounting for about one-quarter of the cases (28.7%). A diagnosis of acid-base imbalance existed in 78 patients (82.9%). Approximately 47 out of 100 had respiratory alkalosis, 17 had metabolic alkalosis, 12 had high anion gap metabolic acidosis and 7 had mixed acid-base disorders. A further 17% of the infected did not experience any changes in acid-base conditions. Patients with HAGMA had the largest MELD scores (27.3) compared to those with respiratory alkalosis, whose scores were lower (16.4). In 88% of cases, low serum albumin required correcting the gap by revisiting the serum anion calculation. Those with mixed disorders spent more days in hospital and were more likely to face complications.

Figure 1

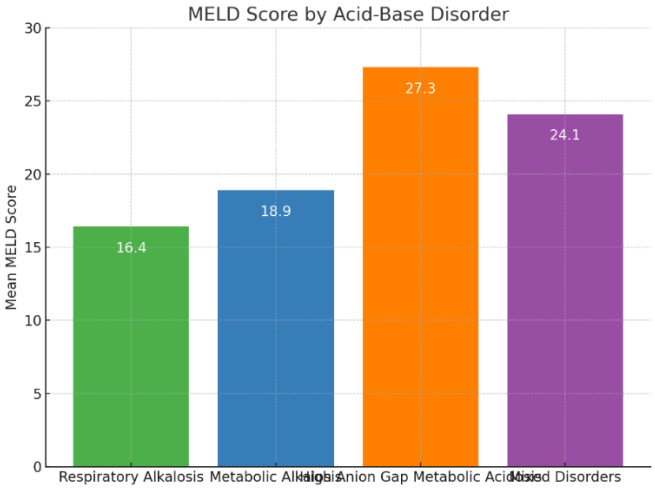

Figure 2

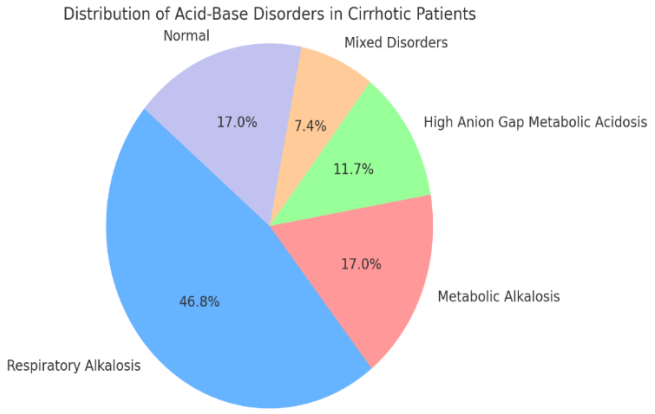

Table 1

Baseline Demographics and Clinical Data

Parameter	Value
Total Patients	94
Mean Age (years)	54.7 ± 9.6
Male (%)	65%
Female (%)	35%
Most Common Etiology	Hepatitis C (41.5%)

Table 2

Distribution of Acid-Base Disorders

Acid-Base Disorder	Number of Patients	Percentage (%)
Respiratory Alkalosis	44	46.8
Metabolic Alkalosis	16	17.0
High Anion Gap Metabolic Acidosis	11	11.7
Mixed Disorders	7	7.4
Normal	16	17.0

Table 3

MELD Scores by Disorder Type

Acid-Base Disorder	Mean MELD Score ± SD
Respiratory Alkalosis	16.4 ± 4.5
Metabolic Alkalosis	18.9 ± 3.7
High Anion Gap Metabolic Acidosis	27.3 ± 3.8
Mixed Disorders	24.1 ± 4.2

DISCUSSION

Acid-base monitoring in people with liver cirrhosis uncovers many cases of imbalance and respiratory alkalosis turns out to be the most common problem. Similar to earlier studies, the data suggests that nearly three-quarters of cirrhosis patients develop respiratory alkalosis because of hyperventilation brought on by hepatic encephalopathy, lack of oxygen or shunting of fluid in the liver. The fact that 17% of our patients had metabolic alkalosis shows that diuretic overuse and GI fluid losses are common in cirrhosis patients treated for ascites and hepatic encephalopathy. Kim et al. explain that routinely giving loop diuretics to people with liver disease often leads to more fluid being lost from outside the cells and a loss of chloride, contributing to a metabolic alkalosis [14]. It is very important to notice this pattern, since constant alkalosis increases the chance of ammonia reaching the brain from the blood and making hepatic encephalopathy worse. HAGMA, seen in 11.7% of cases, was linked with worse clinical results and higher MELD scores found in our study. This finding agrees with what Bernardi et al. reported, showing that cirrhosis with lactic acidosis often leads to a poor outcome [15]. Problems with liver clearing lactate and extra lactate created by tissue hypoxia or sepsis lead to this complication. Also, when the kidneys of someone with cirrhosis fail, whether from hepatorenal syndrome or acute tubular necrosis, acidosis may occur since ammonium excretion and bicarbonate reuptake have been reduced [16]. It is challenging to detect hypoalbuminemia as a cause of illness. Since albumin doesn't get measured in standard tests, low levels in cirrhotic patients might disguise important acid-base problems by making the anion gap appear normal. Wrenn et al. have shown that correcting the anion gap using albumin helps increase the sensitivity of tests for metabolic acidosis in patients with low blood albumin [17]. Lower in frequency (7.4%), mixed acid-base disorders led to longer hospital stays and a higher risk of death in the participants included in our study. The presence of both metabolic and respiratory problems in these patients complicated their clinical assessment. Gines et al. explained that using ABG in conjunction with biochemical data and hepatic systems is necessary to predict how well the patient will do and what medical intervention should be considered [18]. Overall, our results underline that it is very important to spot and classify acid-base problems in cirrhosis. If the underlying disease—infections, renal failure or drugs—is found and treated early, the risk of complications is lowered, hospital stays can be reduced and outcomes in cirrhosis patients can improve.

CONCLUSION

Problems with acid and base balance often develop and are important in patients with cirrhosis. Most often, patients will get respiratory alkalosis, but mixed disorders and those with high anion gaps are more dangerous. So far, improved diagnosis tools and timely treatment help improve outcomes and steer the right medical choices in those with cirrhosis.

Limitations

With just one site and a relatively small sample, the findings cannot be generalized to other groups. Following the treatment, there was not enough data to assess how acid-base correction continued. Furthermore, some important conditions that could affect acid balance in patients, like comorbidities, previous medications and nutrition, were not systematically studied.

Future Directions

Future studies that investigate multiple hospitals should look at the ongoing effects of different acid-base problems on the health and survival of cirrhosis patients. Using albumin-adjusted anion gap and lactate clearance changes may improve how accurately the condition is diagnosed. There is a need to observe how effective early correction plays a part in the results of organ transplants.

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