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Association of metabolic acidosis with disease severity in chronic liver disease: A prospective observational study

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Abstract
Background: Chronic liver disease (CLD) is associated with multiple metabolic derangements, including disturbances in acid–base balance due to impaired lactate metabolism, reduced hepatic clearance, and systemic complications. Metabolic acidosis, particularly lactic acidosis, has been associated with disease severity and adverse outcomes in cirrhotic patients.
Aim: To evaluate the association between metabolic acidosis and severity of chronic liver disease using Child–Pugh classification and MELD score, and to assess its relationship with complications such as hepatic encephalopathy, hepatorenal syndrome, and ascites.
Methods: This prospective cross-sectional observational study included 96 patients diagnosed with chronic liver disease admitted to a tertiary care hospital between September 2022 and August 2024. Arterial blood gas analysis was performed to assess acid–base status, including pH, bicarbonate, base excess, and lactate levels. Clinical, biochemical, and radiological parameters were recorded. Disease severity was assessed using Child–Pugh and MELD-Na scores. Statistical analysis was performed using SPSS version 20.
Results: The study population was predominantly male (96.9%), with alcohol being the most common etiology (93.8%). Metabolic acidosis was observed in 46.8% of patients, while respiratory alkalosis was seen in 12.5%. Among patients with metabolic acidosis, 80% belonged to Child–Pugh Class C and 20% to Class B. A higher proportion of patients with metabolic acidosis had elevated MELD-Na scores (20–39), indicating increased disease severity and mortality risk. Metabolic acidosis was more frequently observed in patients with complications such as ascites, hepatic encephalopathy, and hepatorenal syndrome.
Conclusion: Metabolic acidosis is common in patients with advanced chronic liver disease and correlates with higher Child–Pugh and MELD scores, reflecting increased disease severity. Early recognition of acid–base disturbances may serve as an important prognostic indicator and aid in risk stratification and management of patients with cirrhosis.

Keywords: Chronic liver disease, cirrhosis, metabolic acidosis, lactic acidosis, Child–Pugh Score, Meld Score, acid–base disorders, hepatic encephalopathy, ascites, hepatorenal syndrome

Introduction

- Cirrhosis is an irreversible liver disease characterised by chronic hepatocyte destruction that cannot be reversed. Fibrosis in the liver can disrupt its architecture and cause reactive nodule regeneration.
- Cirrhosis is described anatomically as a diffuse process with fibrosis and nodule formation. The pathological feature is severe hepatocyte destruction, followed by fibrosis and nodule development. This is mostly due to hepatocyte necrosis, loss of the reticular network, and regeneration of surviving liver tissue through nodules.
- Alcohol stimulates metabolism on its own. Cytochrome P4502E1-based Microsomal Ethanol Oxidising System is an alternative mechanism for the metabolism of alcohol.
- Hepatocyte dysfunction can lead to icterus, irregular coagulation, vascular disruptions from fibrosis (portal hypertension), and consequences such as esophageal varices and splenomegaly. Both portal hypertension and hepatocellular damage will lead to ascites and hepatic encephalopathy.

Cirrhosis is divided clinically into two forms:

a. Compensated
b. Decompensated.

Decompensation refers to cirrhosis with additional symptoms such as jaundice, ascites, hepatic encephalopathy, or bleeding varices. In compensated cirrhosis, ascites are not a marker of decompensation or complications from portal hypertension. This divergence has significant clinical implications for prognosis and treatment.

- Removing the underlying cause of a decompensated patient can improve their prognosis.
- Patients with decompensated liver disease should consider a liver transplant.
- Cirrhosis can be clinically staged. The modified CHILD PUGH scoring system is a reliable option. It goes from 5 to 15.

1. Child Pugh CLASS A: Scores of 5-6 indicate compensated cirrhosis.
2. Child Pugh CLASS B: Scores of 7 to 9 indicate decompensated cirrhosis.
3. Child Pugh CLASS C: Scores above 10 indicate decompensated cirrhosis.

Aim and Objective

- To correlate the severity of Metabolic acidosis/ Lactic acidosis with severity of chronic liver disease (Child Pugh A/B/C)

- To correlate between severity of Metabolic acidosis with MELD Score.
- To observe the change in Metabolic acidosis in complications of chronic liver disease like Hepatic Encephalopathy, Hepatorenal syndrome and Ascites.

Material and Method

- The Information for the study will be collected from chronic liver disease patients, including opd and ipd in b.l.d.e(du) shri b.m. Patil medical college, hospital and research centre, vijayapura-583106, karnataka from September 2022-August 2024 with sample size of 96.
- A complete blood gas analysis (ABG) includes pH, partial pressure of arterial oxygen (PaO2), partial pressure of carbon dioxide (PCO2), sodium (Na+), potassium (K+), ionized calcium (Ca2+), magnesium, chloride (Cl−), inorganic phosphate, bicarbonate (HCO3−), BE, and lactate.
- The levels of albumin, alanine aminotransferase (ALT), aspartate aminotransferase (AST), activated partial thromboplastin time, blood urea nitrogen (BUN), creatinine, glucose, haemoglobin, haematocrit, international normalized ratio (INR), platelet count, prothrombin time and USG Abdomen and pelvis.

Inclusion Criteria

- All patients admitted with diagnosis of chronic Liver Disease.

Exclusion Criteria

1. Patients with malignancy
2. Acquired immune deficiency syndrome
3. Post-organ transplant

Type of study

- Prospective Cross- Sectional study

Statistical analysis

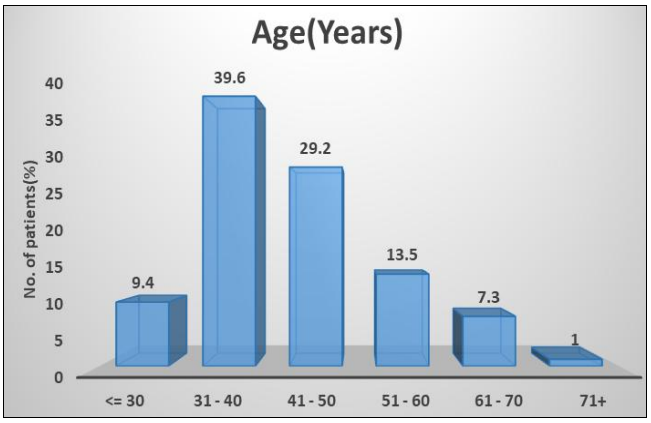
- The data obtained will be entered in a Microsoft Excel sheet, and statistical analysis will be performed using statistical package for the social sciences (Version 20).

Results

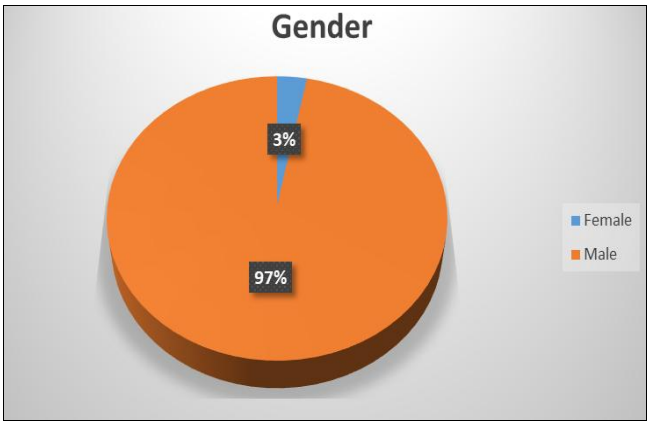
- The average age group of patients predominantly being between 31 to 40 years of age and the youngest being 25 and oldest being 84 years.
- The study population predominantly consisted of male patients (96.8%).
- Among the risk factors, the most common being Alcohol (94.7%) and 13 patients in this study had either Diabetes or HTN (13.5%).
- Majority of patients showed Metabolic Acidosis (46.8 %) and Respiratory Alkalosis (12.5%) and the rest being WNL.
- In the Metabolic Acidosis group, 36 patients were in Class C of CHILD PUGH SCORE (80%) and the rest 9 in Class B (20%).
- Majority of patients were in Class C of CHILD PUGH SCORE (81.25%) and few in Class B (16.6%) and rest in Class A (2.15%).
- Majority of patients were in MELD-Na score of 20-29 (36.4%) which has a 3-year mortality of 19.6 % followed by score of 30-39 (34.3%) which has a mortality of 52.6% and in Metabolic Acidosis group, majority were in score of 20-29 and 30-39 both being 16 patients each (35.5%).

Age (Years)	No. of patients	Frequency
<= 30	9	9.4
31 - 40	38	39.6
41 - 50	28	29.2
51 - 60	13	13.5
61 - 70	7	7.3
71+	1	1.0
Total	96	100.0

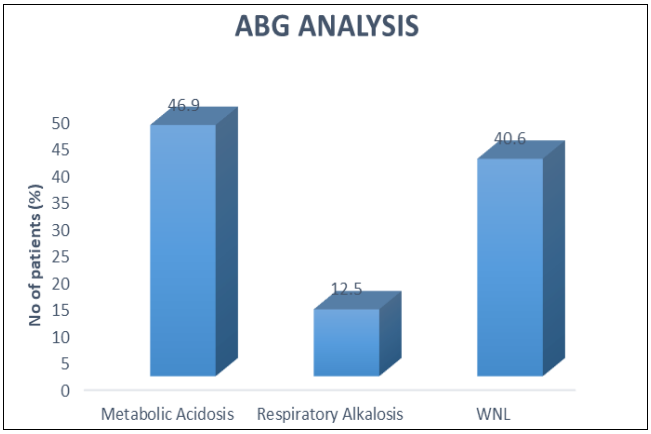
Gender	No. of patients	Frequency
Female	3	3.1
Male	93	96.9
Total	96	100.0

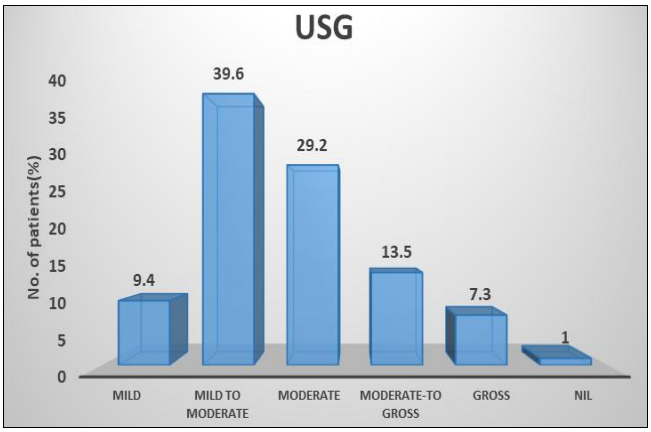


Etiology		
	Frequency	Percent
Alcohol	90	93.8
Others	6	6.3
Total	96	100.0

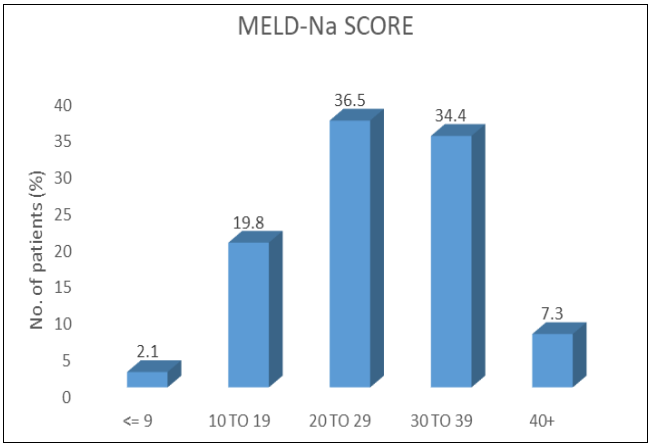


Ascitis	No. of patients	Frequency
Mild	14	9.4
Mild to Moderate	16	39.6
Moderate	19	29.2
Moderate-to Gross	12	13.5
Gross	28	7.3
Nil	7	1.0
Total	96	100.0





Child Pugh Score		
	Frequency	Percent
<= 6	2	2.1
7 - 9	16	16.7
10+	78	81.3
Total	96	100.0



ABG * CHILD PUGH SCORE (Binned) Crosstabulation

			CHILD PUGH SCORE (Binned)			Total
			<= 6	7 - 9	10+	
ABG	Metabolic Acidosis		0	9	36	45
			0.0%	56.3%	46.2%	46.9%
	Respiratory Alkalosis		0	0	12	12
			0.0%	0.0%	15.4%	12.5%
	WNL		2	7	30	39
			100.0%	43.8%	38.5%	40.6%
Total			2	16	78	96
			100.0%	100.0%	100.0%	100.0%

ABG * Lactate (Binned) Crosstabulation

			Lactate (Binned)		
			<= 1.50	1.51+	Total
ABG	Metabolic Acidosis		3	42	45
			23.1%	50.6%	46.9%
	Respiratory Alkalosis		1	11	12
			7.7%	13.3%	12.5%
	WNL		9	30	39
			69.2%	36.1%	40.6%
Total			13	83	96
			100.0%	100.0%	100.0%

Chi-Square Tests

	Value	Asymptotic Significance (2-sided)
Pearson Chi-Square	5.123	.077

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Age	96	25	84	43.45	10.862
Ph	96	6.890	7.580	7.33759	.133630
HCO3	96	5.9	29.3	16.460	5.5094
Lactate	96	.80	16.40	3.6147	3.16626
MELD-NA	96	7	40	26.79	8.716
CHILD PUGH SCORE (Binned)	96	1	3	2.79	.457
Valid N (listwise)	96				

Discussion and Conclusion

- Diagnosis of liver cirrhosis is based on clinical evidence of liver dysfunction/ Portal hypertension, Abnormal LFT and USG.
- Metabolic acidosis is a common reason for intensive care unit (ICU) Admission and associated with increased ICU mortality. Liver is crucial acid-base regulation organ playing important role in lactate metabolism, keto genesis, albumin synthesis and urea production and severe liver damage leads to metabolic acidosis.
- Lactic acidosis occurs when there's an accumulation of lactic acid in the bloodstream beyond the body's capacity to clear it. The liver and kidneys play crucial roles in metabolising and removing excess lactic acid from the body.
- This study thus explains that there is correlation between Cirrhosis and Metabolic Acidosis and sepsis causes increase in Lactate levels and formation of Lactic Acidosis and formation of Metabolic Acidosis.
- There is also a correlation between cirrhosis and Respiratory Alkalosis which is caused due to breathlessness and co2 retention.

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