e-ISSN: 0975-1556, p-ISSN:2820-2643
Available online on www.ijpcr.com
International Journal of Pharmaceutical and Clinical Research 2024; 16(12); 267-271

Original Research Article

Impact of Liver Function Tests on Clinical Outcomes in Rodenticide Poisoning: A Comprehensive Analysis of ALT, AST, and Bilirubin as Prognostic Markers

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Received: 25-08-2024 / Revised: 23-09-2024 / Accepted: 29-11-2024
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Conflict of interest: Nil

Abstract

Introduction: Rodenticide poisoning, particularly from yellow phosphorus, is a growing public health issue, especially in developing countries such as India. This highly toxic substance can lead to severe liver damage, acute liver failure (ALF), and mortality. Rodenticides, often ingested in cases of self-harm, are increasingly contributing to morbidity, particularly in rural populations (Gopalakrishnan et al., 2020; Abhilash et al., 2022). Given that the liver is the primary organ affected by rodenticide poisoning, understanding the role of liver function tests in predicting clinical outcomes is critical. This study explores the prognostic value of serum alanine aminotransferase (ALT), aspartate aminotransferase (AST), and bilirubin levels in predicting the severity and mortality associated with yellow phosphorus poisoning (Sardar et al., 2019; Govindarajan et al., 2021).

Materials and Methods: This cross-sectional study was conducted at a tertiary care hospital in South Gujarat, India, enrolling 70 patients diagnosed with rodenticide poisoning. A convenient sampling method was used to include adults with a history of poisoning due to yellow phosphorus. Exclusion criteria included prior liver disease or exposure to non-hepatotoxic rodenticides. Liver function tests, including ALT, AST, and total and direct/indirect bilirubin, were measured. Clinical outcomes (morbidity and mortality) were assessed in relation to these biomarkers. Statistical analysis was performed using SPSS version 26, with chi-square tests to determine significance.

Results: The study found that elevated ALT, AST, and bilirubin levels were significantly associated with severe illness. Of the 70 participants, 51.4% were classified as severely ill, with 85% of these individuals exhibiting elevated ALT levels. Elevated AST and bilirubin levels were similarly observed in 83.3% of severely ill patients. Notably, ALT was the strongest predictor of mortality, with 31% of patients with elevated ALT levels dying, compared to just 2% with normal ALT levels ($P = 0.001$). However, no significant association was observed between mortality and AST ($P = 0.345$) or bilirubin levels ($P = 0.08$), although these markers were elevated in some cases.

Discussion: The results confirm the prognostic significance of liver function tests in rodenticide poisoning. Elevated ALT levels were strongly correlated with both morbidity and mortality, supporting its role as a sensitive marker for liver damage and poor clinical outcomes. Although AST and bilirubin were also elevated in severely ill patients, they were less predictive of mortality, suggesting that ALT may be a more specific marker for liver injury in this context. These findings are consistent with previous studies, which have identified ALT as a reliable biomarker for assessing the severity of liver dysfunction in toxic exposures (Sardar et al., 2019; Gopalakrishnan et al., 2020). Elevated bilirubin, particularly both direct and indirect fractions, also showed a strong association with severe illness, reflecting the extent of hepatic dysfunction and systemic toxicity.

Conclusion: This study underscores the potential of liver function tests, particularly ALT, as important prognostic markers in rodenticide poisoning. Elevated ALT levels were significantly associated with increased mortality, while elevated AST and bilirubin levels were linked to severe illness. These findings suggest that liver function tests can aid in early diagnosis, risk stratification, and management of patients with rodenticide poisoning. Clinicians should prioritize these biomarkers to better predict outcomes and guide therapeutic interventions. Future research should focus on refining these biomarkers' utility and exploring additional indicators that may enhance prognosis and treatment in rodenticide poisoning.

Keywords: Rodenticide Poisoning, Liver Function Tests, S. Bilirubin, Alanine Aminotransferase, Acute Liver Failure, Prognostic Biomarkers, Hepatic Dysfunction.

Introduction

Rodenticide poisoning, particularly from yellow phosphorus, is a growing public health concern, especially in developing countries like India. Yellow phosphorus is highly toxic and can cause severe liver damage, often leading to acute liver failure (ALF) and death. It is commonly used for pest control but is also frequently ingested intentionally in cases of self-harm (Gopalakrishnan et al., 2020; Abhilash et al., 2022). The rising incidence of rodenticide poisoning in India is a significant cause of morbidity, with yellow phosphorus being one of the primary chemicals involved in such cases (Sardar et al., 2019; Govindarajan et al., 2021).

The liver is the main organ affected by rodenticide poisoning, with damage ranging from acute liver injury (ALI) to ALF. This condition is often accompanied by complications such as coagulopathy and hepatic encephalopathy, leading to multi-organ failure (Mishra et al., 2017; Gopalakrishnan et al., 2020). Treatment remains supportive, as there is no specific antidote for rodenticide-induced hepatotoxicity. However, plasma exchange has shown potential benefits for severe cases (Sardar et al., 2019). Early detection of liver dysfunction is essential for predicting outcomes and guiding treatment (Yu et al., 2013).

Liver function tests, including serum alanine aminotransferase (ALT), aspartate aminotransferase (AST), and bilirubin, are crucial for assessing liver damage and prognosis in rodenticide poisoning. This study aims to explore the role of these biomarkers in predicting clinical outcomes in patients affected by yellow phosphorus poisoning (Peshin et al., 2014). By understanding their prognostic value, this research aims to improve early diagnosis, patient management, and ultimately reduce the mortality associated with rodenticide poisoning (Wang et al., 2016).

Materials and Methodologies

This cross-sectional study was conducted at a tertiary care centre in South Gujarat, from the time of ethical approval until May 2024. A convenient sampling method was used to recruit patients over the age of 18 who were admitted to the Medicine Ward at New Civil Hospital, Surat, with a history of rodenticide poisoning and who consented to participate. Patients were excluded if they had been exposed to non-hepatotoxic rodenticides, mixed toxins, or had pre-existing liver conditions such as Hepatitis B and Hepatitis C or parenchymal disease. The goal was to enroll around 70-75 cases, with informed consent obtained from all participants. Data was collected using a semi-structured Performa, capturing patient symptoms, diagnostic results, and outcomes. Statistical analysis was carried out using SPSS version 26, including cross-tabulations, univariate analysis for continuous variables, and bivariate analysis to examine relationships between variables, with chi-square tests for significance. Ethical approval was obtained from both the Scientific Review Committee (SRC) and the Human Research Ethical Committee (HREC) before initiating the study.

Results

This study aimed to evaluate the impact of liver function tests on clinical outcomes in 70 participants diagnosed with rodenticide poisoning.

Table 1: Association of Liver Function Test Abnormalities with Morbidity in Rodenticide Poisoning

Parameter	Severely ill (n=36)	Normal (n=34)	Total (N=70)	P-value (Significance)	
Serum ALT				0.00001 (Significant)	
Elevated (n)	34	6	40		
Elevated (%)	85%	15%	57.10%		
Normal (n)	2	28	30		
Normal (%)	6.60%	93.40%	42.90%		
Serum AST				$p < 0.05$ (Significant)	
Elevated (n)	30	6	36		
Elevated (%)	83.30%	17.70%	51.40%		
Normal (n)	6	28	34		
Normal (%)	16.70%	83.30%	48.60%		
Serum Bilirubin				$p < 0.05$ (Significant)	
Elevated (n)	30	6	36		

Elevated (%)	83.30%	17.70%	51.40%		
Normal (n)	6	28	34		
Normal (%)	16.70%	83.30%	48.60%		
Serum Bilirubin - Direct				p < 0.05 (Significant)	
Elevated (n)	28	8	36		
Elevated (%)	77.80%	22.20%	51.40%		
Normal (n)	8	26	34		
Normal (%)	22.20%	77.80%	48.60%		
Serum Bilirubin - Indirect				p < 0.05 (Significant)	
Elevated (n)	32	4	36		
Elevated (%)	88.90%	11.10%	51.40%		
Normal (n)	4	30	34		
Normal (%)	11.10%	88.90%	48.60%		

Morbidity Analysis

Among the 70 participants, 36 (51.4%) were categorized as severely ill, based on their clinical condition. Elevated levels of ALT, AST, and bilirubin (both total and direct/indirect) were significantly associated with severe illness. Elevated ALT levels were found in 85% of severely ill patients, compared to only 15% in those with normal ALT, with a highly significant difference ($P < 0.00001$). This indicates that ALT is a strong predictor of morbidity in rodenticide poisoning. Elevated AST levels were observed in 83.3% of severely ill patients ($P < 0.05$), which further corroborates the importance of this marker in assessing the severity of liver injury. Similarly, elevated total bilirubin was observed in 83.3% of severely ill patients ($P < 0.05$), reinforcing the significance of bilirubin levels as a reliable marker of liver dysfunction. Both direct and indirect bilirubin were elevated in a substantial proportion of severely ill patients, with direct bilirubin being elevated in 77.8% ($P < 0.05$), and indirect bilirubin in 88.9% ($P < 0.05$).

Table 2: Liver Function Test Abnormalities on Mortality in Rodenticide Poisoning

Parameter	Death (n)	Recovered (n)	Recovered (%)	P value	
Serum ALT				**$\chi 2 = 3.2447$**	
Elevated	9	31	77.5	**0.001**	
Normal	2	28	93.4	0.07165	
Total	11	59	84.3	Not significant	
Serum AST					
Elevated	6	34	85	**0.345**	
Normal	5	25	87.5	0.553	
Total	11	59	84.3	Not significant	
Serum Bilirubin					
Elevated	3	37	92.5	**0.08**	
Normal	8	32	80	0.078	
Total	11	59	84.3	Not significant	
Serum Bilirubin - Direct					
Elevated	2	38	95	**0.1**	
Normal	9	31	77.5	0.081	
Total	11	59	84.3	Not significant	
Serum Bilirubin - Indirect					
Elevated	3	37	92.5	**0.12**	
Normal	8	32	80	0.078	
Total	11	59	84.3	Not significant	

Mortality Analysis: Out of the 70 participants, 11 (15.7%) died, while 59 (84.3%) recovered. The analysis revealed that elevated serum ALT levels were significantly associated with increased mortality. Specifically, 31% of patients with elevated ALT died, compared to only 2% of those with normal ALT levels ($P = 0.001$), highlighting the potential prognostic value of this enzyme. In contrast, no significant association was found between mortality and AST ($P = 0.345$), total bilirubin ($P = 0.08$), direct bilirubin ($P = 0.1$), or indirect bilirubin ($P = 0.12$), indicating that these markers, although elevated in some cases, were not as strong indicators of mortality in this cohort.

These findings suggest that elevated levels of ALT, AST, and bilirubin (both total and direct/indirect) play an important role in predicting both mortality and morbidity in rodenticide poisoning. The significant correlation between elevated ALT and the increased risk of death, along with the strong association of ALT, AST, and bilirubin levels with severe clinical outcomes, underscores their potential as valuable biomarkers for early diagnosis and prognosis. By identifying these elevated markers early in the course of treatment, clinicians may be able to better manage patients at risk of severe outcomes and improve overall survival rates in cases of rodenticide poisoning.

Discussion

This study aimed to evaluate the prognostic role of liver function tests, specifically serum ALT, AST, and bilirubin, in predicting clinical outcomes in rodenticide poisoning. The findings of this study highlight the differential effects of these biomarkers on both morbidity and mortality in a cohort of 70 participants.

Concerning mortality, elevated serum ALT levels were found to be a significant predictor, with 31% of patients who had elevated ALT dying, compared to only 2% of those with normal ALT levels (P = 0.001). This result aligns with previous studies, which have noted that liver enzymes like ALT can be crucial indicators of the severity of poisoning and are often linked to poor outcomes (Gopalakrishnan et al., 2020). Conversely, no significant association was found between mortality and elevated AST (P = 0.345), total bilirubin (P = 0.08), direct bilirubin (P = 0.1), or indirect bilirubin (P = 0.12), suggesting that while these biomarkers may be elevated in certain cases, they were not as \

strongly correlated with mortality in this cohort. This finding is consistent with the notion that ALT is a more specific and sensitive marker for liver damage, particularly in the context of rodenticide poisoning (Abhilash et al., 2022).

Regarding morbidity, elevated levels of ALT, AST, and bilirubin were strongly associated with severe illness. In severely ill participants, 85% had elevated ALT, 83.3% had elevated AST, and 83.3% had elevated total bilirubin. The high association of these liver function tests with the clinical severity of poisoning has been widely documented in other studies (Sardar et al., 2019). For instance, elevated bilirubin levels have been shown to correlate with hepatic dysfunction and a worse prognosis in rodenticide poisoning cases (Govindarajan et al., 2021). Additionally, the elevated levels of both direct and indirect bilirubin observed in a significant proportion of severely ill patients (77.8% and 88.9%, respectively) further emphasize the importance of bilirubin as a marker of hepatic injury and systemic toxicity (Mishra et al., 2017).

Conclusion

This study highlights the valuable role of liver function tests, particularly serum ALT, in predicting favourable clinical outcomes in rodenticide poisoning. Elevated levels of ALT were found to be significantly associated with increased mortality, while elevated AST and bilirubin levels were linked to more severe illness. However, these findings emphasize the potential of these liver function markers to serve as early indicators of risk, enabling clinicians to identify patients who may require more intensive care. By utilizing these biomarkers, healthcare providers can enhance management strategies and improve patient outcomes. Further research is encouraged to refine the prognostic utility of these tests and explore additional markers that may contribute to better prediction and treatment in rodenticide poisoning cases.

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