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Research Article

A STUDY ON ECG FINDINGS IN ACUTE LIVER CELL FAILURE DUE TO RAT KILLER PASTE POISONING

SETHURAMAN AL, BALAMURALI R, MANIMARAN M, CHITRA S, SATHYA G*

Department of Medical Gastroenterology, Stanley Medical College, Chennai, Tamil Nadu, India.
***Corresponding author: Sathya G; Email: drsathyarajendran@gmail.com**

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ABSTRACT

Objectives: The objective of this study was to study the various electrocardiogram (ECG) manifestations in patients who develop acute liver cell failure due to rat killer paste poisoning.

Methods: Patients who developed acute liver cell failure due to rat killer paste ingestion admitted during the time period of July 2022–December 2022 in our institution were taken up for the study. Serial ECG monitoring was done in all these patients and observed for any changes.

Results: Eighty-eight cases of rat killer paste poisoning that developed acute liver failure during this time period were included in the study. Out of 88 patients, 24 patients (27%) had ECG manifestations. The different ECG manifestations are ST depression with T wave inversion – 13 patients (10 expired), QT prolongation – 8 patients (3 expired), sinus bradycardia – 2 patients, and atrial fibrillation with rapid ventricular rate – 1 patient (expired). The mean time of onset of ECG findings is 22 h from intake of poison. The overall mortality rate is 23% (20 patients). About 70% of expired patients (14 patients) had abnormal ECG manifestations.

Conclusion: ST depression with T wave inversion was the most common ECG manifestation due to rat killer paste poisoning in our study and it correlates with mortality. Since cardiotoxicity due to rat killer paste poisoning is also a major contributor to mortality, proper measures have to be taken to create awareness to the general public regarding the toxicity of rat killer paste.

Keywords: Rat killer paste, Acute liver cell failure, Electrocardiogram changes.

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INTRODUCTION

Rat killer paste poisoning has been an important cause of significant morbidity and mortality in patients who present with deliberate self-harm to the emergency room. Rat killer paste locally available contains yellow phosphorous. It is a more frequent cause of drug or toxin-induced acute liver cell failure than paracetamol and no specific antidote has been identified [1]. It carries a higher mortality rate despite maximum supportive therapy [2]. The other rodenticides which are available contain aluminum, zinc phosphide, and super warfarins.

It is widely available in the local markets of the study area at a very cheaper price. The rat killer pastes which are commercially available include "RATOL" and "RATKIL" (Fig. 1). Very few studies are available at present regarding the diverse manifestations of the poison.

Various observations carried out in our institution revealed cardiotoxicity as the major cause of sudden cardiac arrest and death in rat killer paste poison patients. Hence, this study was undertaken with the objective to study the various electrocardiogram (ECG) manifestations in patients who develop acute liver cell failure due to rat killer paste poisoning.

METHODS

This cross-sectional observational study was conducted in the department of medical gastroenterology in Government Stanley Medical College, Chennai. The study period was between July 2022 and December 2022. Ethical Committee Approval was obtained on July 13, 2022 (registration no: ECR/131/Inst/TN/2013/RR-22). After obtaining ethical committee clearance, all patients who were admitted with an alleged history of rat killer paste poison ingestion and who developed acute liver cell failure in our hospital during the study period were included in the study. Informed consent was obtained for all patients. All patients with age <18 years of age, patients with age >60 years of age, patients with a known cardiac disease in the past, known diabetic and hypertensive patients, and patients with chronic liver disease in the past were excluded from the study. A detailed clinical history was taken with reference to age, sex, nature and amount of poisoning, the time between consumption and reporting to the hospital, duration of stay in the hospital, and outcome. Vital parameters were recorded.

Blood counts, renal function test, liver function test, and coagulation profile were sent at admission in all cases. Continuous ECG monitoring was done in all cases from admission time till the end of their stay in the hospital. Baseline ECG was taken and serial ECG monitoring was done every 6 h throughout their duration of hospital stay.

The collected data were analyzed with IBM SPSS statistics for Windows version 29.0 (Armonc, NY: IBM Corp). To describe the data, descriptive statistics, frequency analysis, and percentage analysis were used for categorical variables, and the mean and standard deviation were used for continuous variables. To find the significant difference between the bivariate samples in independent groups, the independent sample t-test was used. To find the significance in qualitative categorical data, the Chi-square test was used. In the above statistical tools, the probability value 0.05 is considered a significant level (*$p<0.05$).

RESULTS AND DISCUSSION

Totally 88 patients with an alleged history of rat killer paste poisoning who developed acute liver cell failure during the study time period were taken up for the study. Out of these, 55 were male and 33 were female. The mean age group of the study population is 30.2 years.

The mean quantity of rat killer paste consumed was 7.5 g. 20 cases presented within 2 h of ingestion, 44 cases presented within 2–6 h, 17 cases presented within 6–24 h, and eight cases presented after 24 h of ingestion of poison to our center. All 88 patients developed varying grades of hepatic encephalopathy and coagulopathy as evidenced by deranged prothrombin time (PT). The mean maximum PT international normalised ratio was 6.7. Injection of fresh frozen plasma and injection of Vitamin K was given for correcting coagulopathy. The mean maximum total bilirubin was 8.0 mg/dL.

Serial ECG monitoring was done and baseline ECG was within normal limits for all patients. Out of a total of 88 patients, 24 patients (27%) had various ECG manifestations (Fig. 2). The different ecg changes are ST depression and t wave inversion which occurred in 13 patients, QT prolongation which occurred in 8 patients, sinus bradycardia which occurred in two patients and atrial fibrillation with rapid ventricular rate which occurred in one patient. Out of 13 patients with ST depression with t-wave inversion, 10 patients expired, three out of eight patients with QT prolongation expired, one patient atrial fibrillation expired and no mortality was observed in sinus bradycardia group. The mean time of onset of ECG findings is 22 h from the intake of poison. ECG changes persisted for an average of 4.5 days. The overall mortality rate is 23% (20 patients) (Fig. 3). 70% of expired patients had ECG manifestations and it is statistically significant (Table 1). Univariate analysis was done and no significant correlation was found between various other variables (Table 2).

Rodenticide poisoning is common in India and many other parts of the world. About 90% of our cases reported suicidal ingestion whereas 10% of cases accidentally ingested rat killer paste. In the study on zinc phosphide poisoning by El Naggar and El Mahdy, 83.6% was suicidal and 16.4% was accidental in intent [3].

In India, the peak incidence of rodenticide poisoning is between 20 and 30 years [4]. In our study, the mean age group of patients is 30.8 years. Most of the domestically available rat killer pastes are available in tube form which contains 15 g per tube. In our study, the mean tube ingestion was ½ tube containing 7.5 g.

Yellow phosphorous which is used in the manufacture of rodenticide is a highly cellular toxin. Rodenticides with 3–5% of yellow phosphorus are currently available (RATOL-3%) [5-7]. It is pyrophoric and very inflammable. It is a non-metallic protoplasmic poison affecting the hepatic, gastrointestinal, cardiovascular, and renal systems. The least fatal dose is 8 mg, and the usual fatal dose is 1 mg/kg [5]. In our study, the deceased ingested approximately 7.5 g of the rodenticide. Yellow phosphorous causes multiorgan failure. The main mechanism by which it causes toxicity is exothermic reaction which produces phosphoric acid which causes direct tissue damage by producing free radicals which in turn affects the ribosomal function and protein synthesis. Cardiotoxicity can also occur due to secondary peripheral vascular collapse that decreases the coronary blood flow resulting in severe myocardial ischemia, hemodynamic instability, and arrhythmia. The ECG changes can also be due to dyselectrolytemia secondary to renal toxicity due to the poison. All causes of dyselectrolytemia were ruled out.

About 28% of patients had ECG changes in our study. Chugh *et al.* also have reported conduction disturbances and arrhythmia in 38% of patients with rodenticide poisoning in his study [8].

In a study on ECG changes on rodenticide poisoning by Soltaninejad *et al.*, the ECG changes or cardiovascular symptoms appeared between 3 and 5 h after admission [9]. In a study by Sugunan *et al.*, the mean time of onset of ECG changes is 19.7 h [10]. In our study, the average time interval between intake of poison and the appearance of ECG findings was 22 h.

In our study, the abnormal ECG findings persisted for 4.5 days whereas in a study by Sugunan *et al.* it persisted for an average of 6.4 days [10].

Fig. 1: Commercially available image of rat killer paste

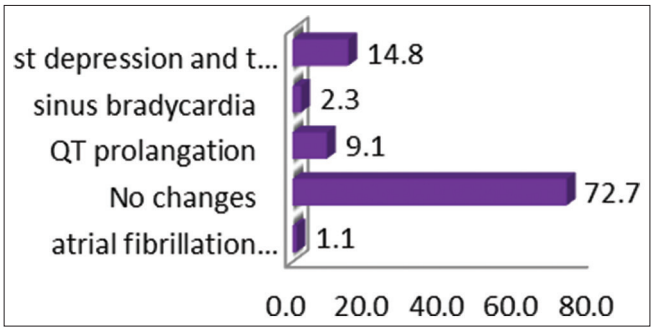

Fig. 2: Frequency of different electrocardiogram changes in the study population

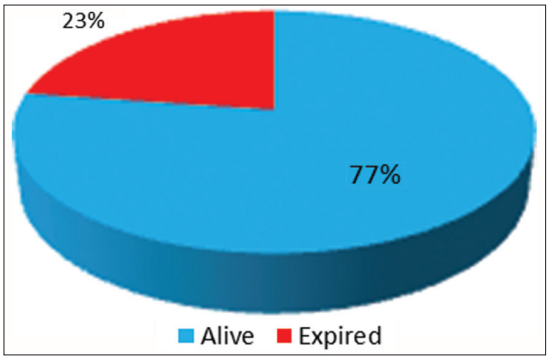

Fig. 3: Overall mortality rate in the study population

Table 1: Frequency of ECG changes

ECG changes	Status		Total
	Alive	Expired	
Absent			
Count	58	6	64
%	85.3	30.0	72.7
Present			
Count	10	14	24
%	14.7	70.0	27.3
Total			
Count	68	20	88
%	100.0	100.0	100.0
	Value	**Df**	**p-value**
Pearson Chi-square	23.823[a]	1	0.0005

*Comparison of ECG changes in alive and expired populations. The presence of ECG changes correlates with mortality and it is statistically significant, ECG: Electrocardiogram

The different ECG changes in our study are ST depression with T wave inversion, which occurred in 13 patients; QT prolongation, which occurred in eight patients; sinus bradycardia, which occurred in two patients; and

Table 2: Independent sample test

Variables	Levene's test for equality of variances		t-test for equality of means						
	F	Sig.	T	Df	p-value	Mean difference	Standard error difference	95% Confidence interval of the difference	
								Lower	Upper
Age									
Equal variances assumed	0.202	0.654	−1.114	86	0.268	−3.8529	3.4592	−10.7296	3.0237
Hospital stay									
Equal variances assumed	1.390	0.242	0.551	86	0.583	4.8235	8.7487	−12.5683	22.2154
Total bilirubin									
Equal variances assumed	3.920	0.051	−1.142	86	0.257	−2.4179	2.1168	−6.6261	1.7902
SGOT									
Equal variances assumed	0.486	0.487	−0.420	86	0.676	−133.7706	318.6126	−767.1515	499.6103
SGPT									
Equal variances assumes	0.585	0.446	0.285	86	0.776	38.3235	134.5679	−229.1886	305.8357
PT									
Equal variances assumed	1.867	0.175	−1.471	86	0.145	−9.7227	6.60844	−22.8599	3.4143
INR									
Equal variances assumed	0.316	0.576	−0.393	86	0.695	−0.87771	2.23324	−5.3172	3.5618
Hour of base line ECG									
Equal variances not assumed	9.521	0.005	−1.675	21	0.109	−5.9333	3.5419	−13.2951	1.4284
Hour of onset of ECG changes									
Equal variances assumed	0.884	0.357	−0.632	22	0.534	−2.9333	4.6423	−12.5608	6.6942
Hours of persistence of ECG changes									
Equal variances assumed	0.365	0.552	1.362	22	0.187	14.4000	10.5729	−7.5269	36.3269

SGOT: Serum glutamic oxaloacetic transaminase, SGPT: Serum glutamic pyruvic transaminase, PT: Prothrombin time, INR: International normalized ratio, ECG: Electrocardiogram, *Analysis of significant difference between Bi-variate samples in independent groups using independent sample t-test

atrial fibrillation with rapid ventricular rate, which occurred in one patient. In our study, ST depression with T wave inversion was the commonest ECG manifestation whereas in a study by Sugunan *et al*. global t wave inversion was proposed as the most common ECG manifestation [10].

Varying mortality rates have been reported ranging from 25% to 77% in various rodenticide poisoning studies available [11,12].Out of 13 patients with ST depression with t-wave inversion 10 patients expired, three out of eight patients with QT prolongation expired, one patient atrial fibrillation expired and no mortality was observed in sinus bradycardia group. Mortality of 23% in our study is comparable to other previous studies. The main limitations of this study are the small sample size and itself being a single-centric study.

CONCLUSION

ST depression with t-wave inversion is the most common ECG manifestation due to rat killer paste poisoning in our study and it correlates with mortality. Hence, continuous ECG monitoring must be done. The possibility of multiorgan failure and high risk of mortality due to these rodenticides must be made aware to the general public to avoid consumption.

AUTHOR'S CONTRIBUTION

All authors equally participated in conducting the study, interpreting the results, and writing the manuscript.

CONFLICT OF INTEREST

There are no conflicts of interest in this study.

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Nil.

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