Case Study

Fatal Paraquat Poisoning: A Case Report

Vivek Pathak[1], Santosh Kumar[2], Rajiv Ratan Singh[3], Pradeep Kumar Yadav[4], Richa Choudhary[5], Madhulika Shukla[6]

[1]Junior Resident, Department of Forensic Medicine and Toxicology, Dr. Ram Manohar Lohia Institute of Medical Sciences, Lucknow, India, [2]Senior Resident,Department of Emergency Medicine, Dr. Ram Manohar Lohia Institute of Medical Sciences, Lucknow, India, [3]Professor (Jr), Department of Emergency Medicine, Dr. Ram Manohar Lohia Institute of Medical Sciences, Lucknow, India, [4]Assistant Professor, Department of Forensic Medicine and Toxicology, Dr. Ram Manohar Lohia Institute of Medical Sciences, Lucknow, India, [5]Professor (Jr), Department of Forensic Medicine and Toxicology, Dr. Ram Manohar Lohia Institute of Medical Sciences, Lucknow, India, [6]Junior Resident, Department of Forensic Medicine and Toxicology, Dr. Ram Manohar Lohia Institute of Medical Sciences, Lucknow, India.

How to cite this article: Vivek Pathak, Santosh Kumar, Rajiv Ratan Singh et. al. Fatal Paraquat Poisoning: A Case Report. Indian Journal of Forensic Medicine and Toxicology/Volume 19 No. 1, January - March 2025.

Abstract

Paraquat, a widely used herbicide, is notorious for its high toxicity and limited antidotal options. This case report details the clinical presentation, management strategies, and outcomes of a patient with paraquat poisoning. A 32-year-old male presented to the emergency department with a history of intentional ingestion of paraquat. The patient exhibited signs of acute toxicity, including gastrointestinal distress, respiratory distress, and multi-organ failure. Prompt recognition and initiation of treatment were crucial in navigating the complex clinical course. The treatment protocol involved aggressive decontamination, administration of activated charcoal, and utilization of specific antidotes such as cyclophosphamide and methylprednisolone. The patient received supportive care, including mechanical ventilation and hemodynamic support. Continuous monitoring of renal and hepatic functions was implemented to detect and manage complications promptly. Despite the aggressive therapeutic approach, the patient faced significant challenges, with progressive deterioration of respiratory and renal functions. The case highlights the limited efficacy of current treatment modalities in severe paraquat poisoning. The patient eventually succumbed to multi-organ failure, underscoring the need for further research to explore alternative interventions. Paraquat poisoning remains a significant clinical challenge with high mortality rates. This case report emphasizes the importance of early recognition, aggressive decontamination, and advanced supportive care in managing paraquat toxicity. Further research is imperative to explore novel treatment strategies and improve outcomes in cases of severe paraquat poisoning.

Keywords: Paraquat, herbicide poisoning, toxicology, antidote, multi-organ failure.

Corresponding Author: Pradeep Kumar Yadav, Assistant Professor, Department of Forensic Medicine and Toxicology, Dr. Ram Manohar Lohia Institute of Medical Sciences, Lucknow, India.

E-mail: dctrprdp@gmail.com

Submission date: July 30, 2024 **Revision date:** August 21, 2024 **Published date: December 3,2024**

Introduction

Paraquat (1,1-dimethyl-4, 4'-bipyridylium dichloride) is a broad-spectrum, contact herbicide extensively utilized in agricultural sectors globally [1]. In humans, paraquat is extremely toxic, with an estimated lethal dose ranging from approximately 3 to 6 grams of paraquat ion for adults [2]. The primary route of poisoning typically occurs through ingestion, whether intentional or accidental, of the concentrated solution [2,3].Dermal exposure, particularly in individuals with pre-existing skin lesions, has been documented to lead to severe paraquat poisoning. Inhalation of sprayed paraquat solution typically causes local irritation with minimal systemic absorption [3]. Upon ingestion, approximately 20% of paraquat is absorbed by the gastrointestinal tract, with higher absorption rates noted in the presence of ulcerated mucosa or an empty stomach [4]. Paraquat undergoes minimal metabolic processing in the body, with over 90% excreted unchanged by the kidneys. [4] At the tissue level, paraquat undergoes reduction to paraquat radicals in the presence of reduced nicotinamide adenine dinucleotide phosphate (NADPH) [5]. Subsequently, these paraquat radicals interact with oxygen molecules, leading to the production of superoxide anion (O2 –) [6]. Excessive levels of superoxide anion facilitate the formation of hydroxyl free radicals (OH–), which have the potential to induce cellular damage through processes such as lipid peroxidation and inhibition of crucial cellular enzymes [6]. This mechanism elucidates why the lungs are particularly vulnerable to paraquat poisoning, as they exhibit high tissue concentrations resulting from active uptake mechanisms and abundant oxygen availability, facilitating the formation of reactive oxygen radicals [6,7]. Between 1985 and 1990, approximately 340,000 cases of agricultural and horticultural poisoning were reported in the United States, resulting in 97 deaths. Although paraquat poisoning comprised only 0.34% of these cases, it had the highest mortality rate, responsible for 13% of all fatal cases [8,9]. In Indian scenario, at a tertiary care institute, Household and agricultural poisons together make up the majority (approximately52%) of the substances found in suspected poisoning cases [10].

Case Summary

The patient presented with worsening epigastric discomfort, severe dysphagia, and progressing shortness of breath in the Department of Emergency Medicine at a tertiary care hospital, in North India. The attendant gave history of ingestion of approximately 20 ml of paraquet which had 250gram of paraquet dichloride in one liter. A chest radiograph at the outset of symptoms showed bilateral infiltration (Figure-1). Blood chemistry indicated elevated levels of blood urea nitrogen, creatinine, and liver enzymes. Arterial blood gas values demonstrated respiratory acidosis. Oxygen supplementation at 10 liters per minute by non-rebreathing mask was required to maintain saturation levels above 88%. By the second day, the chest radiograph depicted bilateral infiltrate showing ARDS and lung ultrasound showed Shred sign (lung consolidation) and B-line (pulmonary edema) (Figure-2). The patient's condition deteriorated, necessitating intubation and mechanical ventilation. Renal function declined, prompting the initiation of hemodialysis. Despite intervention, multiple-organ failure ensued, culminating in death on the fourth day post-admission.

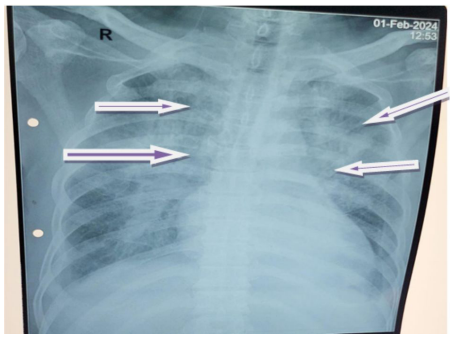

Figure-1: Chest radiograph at the outset of symptoms showed bilateral infiltration (arrow).

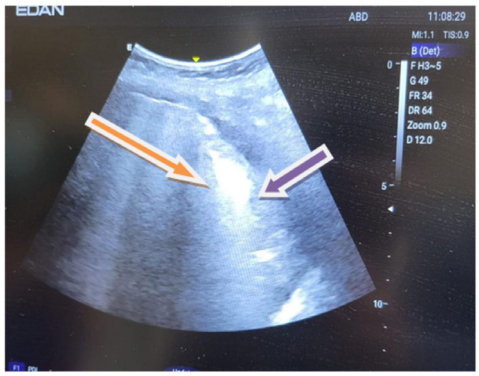

Figure-2: Shred sign (lung consolidation- yellow arrow) and B-line (pulmonary edema- green arrow) in lung ultrasound

Diagnosis: Based on the information provided by the patients' attendants and the observed clinical features, a tentative diagnosis of paraquat poisoning was established.

Treatment: The 32 year male patient arrived at the emergency department, after 4 hour of paraquat ingestion; with chief complain of epigastric discomfort, severe dysphagia, and progressing shortness of breath. Patient had no history of DM/ HTN. There is no similar past history. No significant drug history was reported. Patient was not reported to take any drug for any psychiatric illness or other chronic illness. After clinical suspicion of paraquat poisoning patient was admitted in emergency intensive care unit for further management. On day one, immediately after admission, gastrointestinal decontamination was initiated by the administration of activated charcoal according to body weight followed by intravenous fluids, antiemetic therapy, steroids, N-Acetyl cysteine, and broad spectrum antibiotics to cover secondary infections with a SpO2 reading of 90% on 10 liters of oxygen therapy. Blood, urine and gastric lavage samples collected and sent for analysis. On day two, the patient required tracheal intubation and mechanical ventilation due to tachypnea, cyanosis, GCS E2V2M3, and PaO2 levels around 40 mmHg in arterial blood gas analysis, with other supportive treatments continuing. By day three, the patient developed decreased urine output and low GCS (E1V1M1), complete renal shutdown, metabolic acidosis, and hypokalemia, necessitating hemodialysis. On day four, deranged liver functions and hypotension were observed, and an E-FAST ultrasound examination revealed the shred sign and B lines in the lungs (indicative of lung consolidation and pulmonary edema) and a dilated inferior vena cava, leading to fluid restriction, escalation of antibiotics, and initiation of inotropic support. On day five, the patient developed coagulopathy and rectal bleeding, for which plasma therapy was administered. By day six, Continuous Renal Replacement Therapy (CRRT) was started. Despite all efforts, the patient collapsed and could not be revived on day seven.

Discussion

Ingesting a substantial quantity of concentrated paraquat resulted in the onset of multiple-organ failure within a 24-hour timeframe.[11,12] Individuals experiencing severe paraquat poisoning may initially show no symptoms shortly after ingestion but may deteriorate.[13] Initial management of paraquat poisoning prioritizes the prevention of further absorption and gastrointestinal decontamination. [14] Administering adsorbents promptly is essential. Commonly utilized adsorbents include activated charcoal (1–2 g/kg) and Fuller's earth (1–2 g/kg), often administered alongside a cathartic like 70% sorbitol[12]. While hemoperfusion has demonstrated efficacy in reducing paraquat levels and improving survival in animals, its benefits in humans remain inconclusive. [16] Hemodialysis should be reserved for patients presenting with acute renal failure. Supportive care involves fluid and electrolyte management, pain control, and cautious avoidance of oxygen supplementation due to its potential to exacerbate paraquat-induced lung injury.[14] No specific antidote for paraquat poisoning exists. Various treatments, such as antioxidants (high-dose vitamin C or E), N-acetylcysteine, nitric oxide supplementation, corticosteroids, cytotoxic agents, or paraquat antibodies, have been explored in sporadic case reports, yielding diverse outcomes.[17] The combination of cyclophosphamide and corticosteroids may offer some benefits in moderate-to-severe cases by mitigating ongoing inflammation and pulmonary fibrosis.[7] Additionally, a limited number of cases have reported lung transplantation following paraquat poisoning[18] Extracorporeal membrane oxygenation may be beneficial; more research is necessary [19]. Despite initial management efforts and supportive care, the severity of parquet poisoning led to multiple-organ failure and eventual death. Limitations of this case include the absence of a specific antidote for paraquat poisoning and excessive free radical formation with oxygen therapy. Free radicals induce cellular death and irreversible organ failure. Despite the excessive free radical formation from oxygen therapy, reducing oxygen concentration significantly is challenging, especially in cases of respiratory failure. Additionally, the lack of timely access to advanced medical interventions, such as extracorporeal membrane oxygenation, hemoperfusion or lung transplantation, may have further restricted the potential for successful outcomes [19].

Conclusion

In conclusion, the case report of fatal paraquat poisoning underscores the urgent need for heightened awareness, prompt recognition, and effective management strategies for this highly toxic herbicide. The presented case highlights the devastating

consequences of paraquat ingestion, including rapid progression to multiple-organ failure and ultimately death. Despite advancements in medical care, the lack of a specific antidote for paraquat poisoning continues to pose significant challenges in clinical management. Furthermore, the limited therapeutic options available underscore the importance of preventive measures and public health interventions to mitigate the risk of paraquat exposure.

Recommendations:

Consider advocating for the enforcement of stringent regulations governing paraquat sale and distribution, alongside targeted public awareness campaigns. It might be beneficial to focus on strengthening healthcare infrastructure in agricultural regions to effectively manage poisoning cases. Allocating resources for research into antidote development can be prolific idea.

Consent: Written informed consent was taken from the relative after explaining the purpose of the research.

Source of funding: There is no source of funding.

Conflict of interest: There is no conflict of interest to declare.

Ethical clearance: Not required since it is a case report.

References

1. Blanco-Reina E, Saiz-Rodríguez M, Llerena A. Safety and efficacy of paraquat self-poisoning prevention through restricted sales. Clin Toxicol. 2019;57(1):9-15.
2. Gawarammana IB, Buckley NA. Medical management of paraquat ingestion. Br J Clin Pharmacol. 2011;72(5):745-757.
3. Wesseling C, van Wendel de Joode B, Ruepert C, León C, Monge P, Hermosillo H, et al. Paraquat in developing countries. Int J Occup Environ Health. 2001;7(4):275-286.
4. Dinis-Oliveira RJ, Duarte JA, Sánchez-Navarro A, Remião F, Bastos ML, Carvalho F. Paraquat poisonings: mechanisms of lung toxicity, clinical features, and treatment. Crit Rev Toxicol. 2008;38(1):13-71.
5. Leong PK, Chen HY, Ko KM. Mitochondrial-targeted paraquat and metformin mediate ROS production to induce multiple pathways of retrograde signaling: A dose-dependent phenomenon. J Cell Mol Med. 2015;19(11):2553-2565.
6. Hou Y, Wang Y, Wang H, Xu J, Zheng Y. Identification of paraquat-induced ferroptosis in lung epithelial cells. Toxicol In Vitro. 2018;52:110-119.
7. Wilks MF. Mechanism of action of paraquat. Toxicology. 2003;187(1):1-2.
8. Klein-Schwartz W, Smith GS. Agricultural and horticultural chemical poisonings: mortality and morbidity in the United States. Ann Emerg Med 1997;29(2):232–238.
9. Sittipunt C. Paraquat poisoning. Respiratory care. 2005 Mar 1;50(3):383-5.
10. Chaudhary R, Singh RR, Tripathi SK, Yadav PK. Trends of Poisoning Cases Coming to a Tertiary Care Center in Lucknow: A Retrospective Observational Study. Prof. SK Dhattarwal. 2024 Jan;18(1):109
11. Buckley, N. A., & Eddleston, M. (2011). Clinical management of paraquat poisoning. Toxicological Reviews, 30(2), 81-97.
12. Pakravan, N., Wesseling, S., Aguirre, E., & Pras, N. (2014). Paraquat Poisoning: A case report and review of the literature. Case Reports in Medicine, 2014, 1-8.
13. Senarathna L, Eddleston M, Wilks MF, Woollen BH, Tomenson JA, Roberts DM, et al. Prediction of outcome after paraquat poisoning by measurement of the plasma paraquat concentration. QJM. 2009;102(4):251-259.
14. Eddleston M, Wilks MF. Management of paraquat poisoning. Toxicol Rev. 2003;22(2):129-137.
15. Bismuth C, Garnier R. Porphyric crisis induced by paraquat poisoning: A clinical and toxicological study of 55 cases. Medicine. 1987;66(4):218-229.
16. Proudfoot AT, Stewart MS, Levitt T, Widdop B. Paraquat poisoning: significance of plasma-paraquat concentrations. Lancet. 1979;313(8111):330-332.
17. Dinis-Oliveira RJ, Duarte JA, Sánchez-Navarro A, Remião F, Bastos ML, Carvalho F. Paraquat poisonings: mechanisms of lung toxicity, clinical features, and treatment. Crit Rev Toxicol. 2008;38(1):13-71.
18. Heyndrickx A, De Broe ME. The effect of N-acetylcysteine on the clinical course of acute urethral poisoning with paraquat. J Toxicol: Clin Toxicol. 1980;17(1-2):185-188.
19. Feng MX, Lu YQ. Performance of extracorporeal membrane oxygenation in patients with fatal paraquat poisoning: grasp for straws?. World Journal of Emergency Medicine. 2021;12(3):232.Top of Form.