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Original Research Article

HEMOPERFUSION AS EARLY APPROACH IN TREATING PARAQUAT POISONING – OUR EXPERIENCE

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ABSTRACT

Background: Paraquat poisoning is a fatal condition due to its toxic effects on the lungs, kidneys, and other vital organs, with limited treatment options available. Early hemoperfusion has been proposed to reduce systemic toxicity and improve survival rates. This study evaluated the efficacy of early hemoperfusion in reducing mortality and complications of paraquat poisoning.

Material and Methods: This hospital-based retrospective cohort analysis included 75 patients who had consumed paraquat herbicide and received hemoperfusion during their illness done over 16 months at NRI Medical College and Super Specialty Hospital from June 2022 to October 2023.Patients who underwent hemoperfusion were categorised into the early (<6 h) and delayed (>6 h) groups. Demographics, clinical outcomes, and complications were analysed, and survival rates were compared between the early and delayed intervention groups.

Results: Among 75 patients, 64% were male, the age group was 20-30 years (44%), and half (47%) presented to the hospital within 6 h of paraquat ingestion. Moderate paraquat consumption was the most common (40%). Lung injury affected 96% of patients, with 73% developing acute kidney injury (AKI), 30% requiring dialysis, and 63% recovering. Acute liver injury (ALI) was noted in 64% of patients, but recovery occurred in only 36% of patients. Severe respiratory distress led to intubation in 65% of patients, with only 6% extubated. Pulmonary fibrosis was the leading complication (76%) and cause of death (73%). Delayed hemoperfusion beyond 6 hours resulted in 100 percent mortality.

Conclusion: Early hemoperfusion is a time-sensitive and effective intervention to reduce mortality and systemic toxicity in paraquat poisoning. A need for prompt intervention and future research to optimise treatment protocols and explore adjunctive therapies.

Keywords: Paraquat poisoning, Hemoperfusion, Pulmonary fibrosis, Acute kidney injury.

INTRODUCTION

Paraquat, chemically identified as r-dimethyl-4,4-bipyridium dichloride, is a highly toxic bipyridyl herbicide first introduced in 1962.[1] Paraquat poisoning remains a significant public health problem due to its high mortality rate, ranging from 33% to 90%. In deliberate self-harm involving concentrated paraquat, the mortality rate may escalate to as high as 100%, especially in areas where the application of this herbicide is prevalent.[2] Paraquat has been banned in 32 countries, including India, where paraquat dimethyl sulfate was prohibited in 1993.[3]

Management of paraquat poisoning presents a significant clinical challenge. Following ingestion, the compound exhibits low systemic absorption (1-5%) but is distributed rapidly, with a volume of distribution of 1-2 L/kg. Paraquat primarily targets the lungs, leading to progressive pulmonary fibrosis, with additional toxic effects on the heart, liver, and kidneys.[4] The compound is predominantly excreted unchanged in the urine, but its elimination half-life (approximately 84 hours) underscores the prolonged systemic exposure and organ damage it causes. The overall mortality rate from paraquat poisoning ranges from 40-80%, reflecting the limited efficacy of current therapeutic options.[4]

Given the limitations of existing treatments, such as gastric decontamination, supportive care, and symptomatic management, the search for effective interventions is urgently needed. Current therapeutic approaches often fail to mitigate the toxic effects of paraquat, resulting in poor patient outcomes. This emphasises the critical need for innovative and evidence-based strategies to improve survival rates.[5] Hemoperfusion, a blood purification technique, has drawn interest as a potential therapeutic approach for paraquat poisoning. This technique operates by directly removing paraquat from the bloodstream, thereby reducing its systemic toxicity and limiting damage to vital organs such as the lungs, heart, and kidneys.[6,7] Early initiation of hemoperfusion is particularly advantageous, as it maximises the removal of paraquat before it causes irreversible damage to tissues.[8]

Previous studies have suggested that hemoperfusion may offer substantial benefits by enhancing toxin clearance and mitigating the oxidative damage induced by paraquat. Furthermore, combining hemoperfusion with other supportive measures, such as haemodialysis for renal clearance and corticosteroid therapy for inflammation, could synergistically improve patient outcomes.[9] The timing of intervention is crucial, as early hemoperfusion has the potential to significantly reduce mortality and morbidity associated with severe paraquat poisoning.[10] This study aims to evaluate the efficacy of early hemoperfusion in reducing mortality among patients with paraquat poisoning. By analysing the outcomes of patients treated at a tertiary care centre, this study seeks to provide evidence-based insights into the role of hemoperfusion as a critical therapeutic intervention for this life-threatening condition.

Aim: This study aimed to evaluate the effectiveness of early hemoperfusion in reducing mortality among patients with paraquat poisoning treated at a tertiary care centre.

MATERIALS AND METHODS

This hospital-based retrospective cohort analysis included 75 patients who had consumed paraquat herbicide and received hemoperfusion during their illness done over 16 months at NRI Medical College and Super Specialty Hospital from June 2022 to October 2023.This study was approved by the Institutional Ethics Committee before initiation, and informed consent was obtained from all patients.

Inclusion Criteria

Patients in all age groups with a confirmed history of paraquat ingestion were included in the study.

Exclusion Criteria

Patientswith pre-existing renal chronic kidney disease, immunocompromised status, or a history of pulmonary diseases such as chronic obstructive pulmonary disease (COPD) or interstitial lung disease (ILD) were excluded.

Methods

Hemoperfusion was initiated within 30 min of hospital presentation for eligible patients, with three sessions performed for each, lasting 8 h per session with a 1-hour gap in between. In patients with elevated serum creatinine levels, hemoperfusion was combined with haemodialysis. Adjunctive treatments included nasogastric tube insertion and activated charcoal gastric lavage within one hour of ingestion, intravenous fluids (normal saline) for renal clearance, corticosteroid therapy with dexamethasone 4 mg intravenously three times daily, vitamin C supplementation at 500 mg once daily, and antibiotics as required. Demographic data, clinical history, timing of intervention, and treatment outcomes were meticulously recorded, including parameters, such as the amount of paraquat ingested, delay in hospital presentation, renal function markers, and mortality outcomes. Data are presented as frequencyand percentage.

RESULTS

A total of 75 patients were included in the study. Mostpatients were male (n=48, 64%) and women (n=27, 36%).Mostpatients were aged 20-30 years 33 (44%), followed by those aged > 30 years, 30 (40%).The smallest proportion of patients was in the 10–20 years age group, with 12 (17%). Half of the patients 35 (47%) presented to the hospital within 6 hours of ingestion, while 28 (37%) were admitted within 6–24 hours. A subset of 12(16%) patients presented > 24 hours after ingestion. The amount of paraquat ingested was classified as mild (<10ml), moderate (10-20 ml), severe (> 20ml).[16] A significant proportion of patients fell into the moderate consumption category,30 (40%). Those categorised as mild and severe for 23 (30%) each. [Table 1]

Table 1: Demographic characteristics of the study

Category		Frequency (%)
Sex	Male	48 (64%)
	Female	27 (36%)
Age (years)	10-20	12 (17%)
	20-30	33 (44%)
	>30	30 (40%)
Time to admission (hours)	6	35 (47%)
	6-24	28 (37%)
	>24	12 (16%)
Amount consumed	Mild	23 (30%)
	Moderate	30 (40%)
	Severe	23 (30%)

Lung injury emerged as the most affecting 72 (96%) patients.AKI was observed in 55(73%), with 23 (30%) requiring haemodialysis. Recovery from AKI was in 47 (63%). Acute liver injury was in 48 (64%), of whom only 27 (36%) exhibited recovery. Respiratory management showed that 65 (86%) of patients required intubation due to severe respiratory distress, though successful extubation was achieved in a small fraction of 5 (6%). Among complications, pulmonary fibrosis was the most frequent, affecting 57 (76%), followed by pneumonia in 27 (36%). Less common but severe complications included pneumothorax 5 (6%), pneumomediastinum or oesophageal perforation 2 (3%), and deep vein thrombosis (DVT) 2 (3%).Pulmonary fibrosis for most deaths, 55 (73%). Additional causes of death included pneumonia in 17 patients (23%), metabolic acidosis in 8 patients (10%), and pneumothorax or pneumomediastinum in 8 patients (10%). [Table 2]

Table 2: Mean clinical characteristics

Category		Frequency (%)
Lung Injury		72 (96%)
AKI	On presentation	55 (73%)
	Required HD	23 (30%)
	Recovered	47 (63%)
Acute liver injury	Total	48 (64%)
	Recovered	27 (36%)
Consequences of paraquat poisoning	Intubation	65 (86%)
	Extubated	5 (6%)
Complications	Pneumonia	27 (36%)
	Pulmonary fibrosis	57 (76%)
	Pneumothorax	5 (6%)
	Pneumomediastinum/oesophageal perforation	2 (3%)
	DVT	2 (3%)
Cause of death	Pulmonary Fibrosis	55 (73%)
	Metabolic acidosis	8 (10%)
	Pneumonia	17 (23%)
	Pneumomediastinum/pneumothorax	8 (10%)

Early hemoperfusion within 6 hours significantly improves survival, with a 43 percent survival rate. Delayed hemoperfusion beyond 6 hours resulted in 100 percent mortality. The findings highlight the critical need for early intervention in paraquat poisoning. [Table 3]

Table 3: Outcomes by Timing of Hemoperfusion

TIME OF HP	NO OF CASES	NO OF DEATHS	SURVIVED	% OF SURVIVAL	P value
<6 HRS	35	20	15	43%	<0.0001
>6 HRS	40	40	0	0%	

DISCUSSIONS

This study evaluated the outcomes of early hemoperfusion in patients with paraquat poisoning, highlighting its efficacy in reducing mortality when initiated within six hours of ingestion. The findings revealed that 20% of the patients who underwent hemoperfusion within six hours survived, whereas delays beyond six hours resulted in 100% mortality. These outcomes underscore the time-sensitive nature of hemoperfusion and its critical role in improving survival rates.

These findings are consistent with those reported by Hsu et al. (2012), who observed significantly lower mortality (38%) in patients receiving hemoperfusion within four hours, compared to higher mortality (81%) when initiated after five hours.[9] Another relevant study by Yu Hua (2011) demonstrated that hemoperfusion significantly improved outcomes in paraquat poisoning. In this study, the survival rates were 53.3% and 12.5% in the hemoperfusion and non-hemoperfusion groups, respectively ($p < 0.001$).

The hemoperfusion group also showed reduced incidences of acute respiratory distress syndrome (ARDS) and multiple organ failure (MOF).[11]

Pulmonary complications, particularly pulmonary fibrosis, were the leading cause of death in our study, affecting 76% of the patients and accounting for 73% of the fatalities.Yu Hua (2011) reported a similar trend, noting that the incidence of pulmonary complications, including fibrosis, was significantly lower in patients treated with hemoperfusion compared to those receiving conventional therapy ($p < 0.01$).[11] Additionally, Choi et al. (2011) observed that hemoperfusion effectively reduced plasma paraquat levels, leading to a lower risk of progressive lung injury and improved overall survival rates.[12]

AKI was observed in 73% of the patients, and 30% required haemodialysis. In comparison, Zhang Hong-me (2016) demonstrated that hemoperfusion significantly reduced the incidence of renal complications, with patients in the hemoperfusion group showing improved renal markers, including lower creatinine levels, compared to the non-hemoperfusion group ($p < 0.05$).[13] The recovery rate of AKI in our study (63%) supports the effectiveness of hemoperfusion in preserving renal function and reducing systemic toxicity.

Although hemoperfusion showed considerable efficacy, combining it with additional therapies may further enhance outcomes. Wu et al. (2014) reported that adding immunosuppressive therapy (cyclophosphamide, methylprednisolone, and dexamethasone) to hemoperfusion increased survival rates from 24.3% to 29.3% ($p < 0.001$).[14] Similarly, Jin-Jia Yao (2013) found that the combination of hemoperfusion and plasma exchange significantly reduced mortality from 67.2% to 43.9% ($p < 0.001$).[15] These findings suggest that multimodal approaches could offer additional benefits.

Our study focused on the timing of hemoperfusion and comprehensive documentation of complications. However, its limitations include its single-centre, retrospective design and lack of long-term follow-up to assess chronic complications, such as pulmonary fibrosis. Future studies should explore the role of combination therapies, optimise hemoperfusion protocols, and include multicentre studies to validate these findings.

Our study emphasises the life-saving potential of early hemoperfusion in paraquat poisoning by reducing mortality and mitigating systemic complications. Rapid response protocols are needed to ensure timely initiation of hemoperfusion. Future research should focus on optimising treatment protocols, exploring the role of adjunctive therapies, and addressing long-term outcomes to improve survival rates in this fatal condition.

CONCLUSION

This study emphasizes the importance of early hemoperfusion in enhancing the survival rates of patients with paraquat poisoning. A 20% survival rate was achieved with hemoperfusion that started within six hours of ingestion, whereas a 100% mortality rate was associated with delayed intervention. The results highlight the significance of early intervention in minimizing complications, such as acute kidney injury and pulmonary fibrosis. To enhance management approaches for paraquat poisoning, future research should concentrate on enhancing treatment regimens, investigating adjunctive therapies, and evaluating long-term results.

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