

Clinical Spectrum of Black Stone Poisoning in Paediatrics; An Experience in a Tertiary Care Hospital

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ABSTRACT

Objective: This study was designed to document the clinical presentation, laboratory findings, complications, and outcomes of black stone poisoning in pediatric patients.

Methodology: This retrospective study was conducted on 58 children under 15 years of age, with moderate to severe black stone poisoning, having moderate to severe symptoms, requiring ICU care, and thus admitted in Pediatric Intensive Care Unit of Children's Hospital Lahore. The study duration was between May 2019 to September 2023. Data included demographics, clinical features, lab results, and treatment strategies.

Results: Among total of 58 children, 38 % were female and 62 % were male, with most frequent age 1 to 5 years. Symptoms appeared within 1 to 2 hours of ingestion, with most patients seeking care within 3 to 6 hours. Common symptoms included facial swelling (100%), neck swelling (96.6%) and difficulty in breathing (79.3%). Complications included angioedema (97%), cola-colored urine (100%), metabolic acidosis (86%), ARDS (5.2%), hepatitis (10.3%), and shock (62.15%). The mortality rate was 7%.

Conclusion: Black stone poisoning in children is severe, requiring supportive care, early airway intervention, and renal replacement therapy. Public education on the dangers of Paraphenylenediamine and improved management strategies are essential.

Keywords: Acute Kidney Injury, Angioedema, Black Stone, Paraphenylenediamine, Pediatric Poisoning, Respiratory Distress

Authors' Contribution:

^{1,2}Conception; Literature research; manuscript design and drafting; ^{3,4}Critical analysis and manuscript review; ⁵Data analysis; Manuscript Editing.

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Introduction

Black stone, also known as Kala pathar, poisoning is of a significant concern in pediatric medicine. It is used in hair dyes that is frequently used in Pakistan. It contains Paraphenylenediamine (PPD). The conversion of PPD to reactive compounds like benzoquinone diamine, and subsequently to compounds like Brandowaski's base, has a potential for severe physiological reactions. There are many

adult cases of black stone poisoning reported in the literature from Pakistan especially from Punjab and Sindh provinces. Even so, paediatric ratio is significantly less as compared to adults. It is a rare but potentially serious condition that affects the pediatric population, causing significant increase in morbidity and mortality rates, at times reaching as high as 68.8% and 20%, respectively as noted in local studies.¹⁻³

Hair dyes contain PPD at concentrations ranging from 0.2% to 3.75%. Notably, as little as three grams of PPD can cause systemic poisoning, and the lethal dose ranges from 7 to 10 grams.⁴ These dyes are available in various forms such as stone, powder, or liquid. Liquid forms are more frequently ingested with suicidal intent, whereas mortality rates tend to be higher with stone forms. Mortality rates vary significantly, ranging from 0.03% to 60%.⁵ Understanding its clinical spectrum is crucial for timely diagnosis and management. The clinical spectrum of black stone poisoning in the pediatric population is a wide range of symptoms and manifestations that can vary in severity. PPD can lead to a cascade of symptoms, both locally and systemically, whether applied topically or ingested. Oral ingestion is particularly dangerous, with outcomes varying based on the dose. Clinical manifestations include angioedema progressing to dysphagia and respiratory distress, intravascular hemolysis, rhabdomyolysis, hepatic necrosis, acute renal failure, myocarditis, and fatal arrhythmias. These symptoms underscore the involvement of multiple systems and the potential for life-threatening consequences from PPD ingestion. Symptoms can vary depending on the dose; smaller doses or when most of the dye is expelled through vomiting typically present with angioedema and hepatitis, while a moderate dose can lead to acute renal failure within the first week.⁶

Early recognition and aggressive airway management are crucial for effective treatment, with supportive management such as maintaining respiratory patency, administering antihistamines, and corticosteroids forming the management protocol. However, even with prompt intervention, cases can still escalate, leading to complications like extensive cervicofacial edema, as illustrated in the presented case report. In such severe instances, emergency procedures like tracheostomy may be necessary when traditional methods like intubation prove unsuccessful. Despite the significant

mortality rate and frequent occurrence of cases, there is currently no antidote specifically available for poisoning caused by PPD.⁷

The purpose of the study is to share our experiences regarding clinical presentation of black stone poisoning, laboratory findings, its detrimental effects and outcomes of hair dye poisoning at critical care unit of The Children's Hospital Lahore.

Methodology

This retrospective study was conducted at the Department of Pediatric intensive care, Children's Hospital & Institute of Child Health, Lahore, Pakistan. All patients till the age of 15 year, admitted in emergency department with history of kala pathar ingestion and having moderate to severe symptoms, requiring ICU care were enrolled in the study. Total 58 patients were included in the study fulfilling the inclusion criteria over the period of 4 years, from May 2019 to September 2023. Demographic details, Detail history, physical examination, investigations, treatment received during admission, course of the disease during stay, complications, duration of stay and outcome recorded on the proforma. Investigations included complete blood count, random blood glucose, RFTs, LFTs, creatinine phosphokinase, lactate dehydrogenase, electrolytes, urine complete examinations and arterial blood gas analysis. ECG was done in patients with arrhythmia. Radiological test included mainly chest X-ray. Ultrasound abdomen, chest and echocardiography were done as per clinical status and requirement. Treatment included gastric lavage, intravenous fluids, steroids, antihistamine, gastroprotection, endotracheal intubation, tracheostomy, mechanical ventilation and inotropes according to clinical status of the patients.

Ethical approval for the study was obtained from the institutional review board of The Children's Hospital, University of Child Health Sciences, Lahore (Ref# 2197/UCHS/-CH) on 12-09-2024.

Results

During the study period, a total of 58 cases of black stone poisoning were reported at The Children's Hospital. Among these, 22 cases (38%) were females, while 36 cases (62%) were males.

The predominant age group affected was between 1 to 5 years, accounting for 58.6% of the cases. Most patients (75.9%) sought medical attention within 3 to 6 hours after ingesting the black stone. Symptoms typically appeared within 1 to 2 hours post-ingestion in the majority of cases (55.2%, n=32). Accidental ingestion was reported in all cases except one, which involved a suicidal attempt.

Clinical findings	No.	Percentage	
Sore throat, Dysphagia	45	77.6	
Muscle aches and tenderness	46	80	
Angioedema	56	97	
Wheezing	34	58.6	
Stridor	23	39.7	
Respiratory distress	44	75.9	
Cola color urine	58	100	
Oliguria	20	34.4	
Acute kidney injury (RIFLE criteria)	Risk	26	44.8
	Injury	4	6.9
	Failure	3	5.2
Hypertension	6	10.3	
Hypotension	36	62.15	

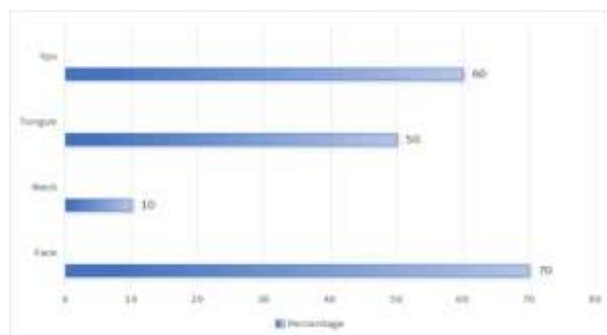


Figure 1: Anatomical sites of angioedema.

The most common presenting complaints included facial swelling (100%), followed by neck swelling (96.6%), and difficulty in breathing (79.3%). Detailed clinical and biochemical findings are listed in Table I.

Investigations	No.	Percentage	
Leucopenia (<4500/mm ³)	2	3.5	
Leucocytosis (>11,000/mm ³)	17	29.8	
Thrombocytopenia (150,000/mm ³)	16	27.6	
Thrombocytosis (450,000/mm ³)	5	8.6	
Raised billirubin (>2mg%)	15	25.9	
Elevated ALT	>80U/L	49	84.5
	>1000U/L Max (5406U/L)	6	10.3
Elevated CPK(>300 U/L)	>300 - 1000 IU/L	46	79.3
	>1000 - 3000 IU/L	4	6.9
	>3000 - 5000 IU/L	3	5.2
	>5000 IU/L Max (45900)	3	5.2
Metabolic acidosis	50	86	

Mostly children (97%) had angioedema of the head, neck, or both. Anatomical sites for edema in patients with black stone poisoning describe in figure 1. All patients were treated with supportive care along with specific management related to the complications in a particular patient such as intravenous fluid, H₂ receptor blockers, steroids in the form of dexamethasone, antihistamine & forced diuresis. Antibiotics were given according to local hospital policy, in case of suspected or proven infection. Out of a total of 58 patients, 90% were successfully discharged, 3% left against medical advice (LAMA) and four patients (07%), expired during the study period. Among them, two patients succumbed to fatal arrhythmia, one to ARDS (Acute Respiratory Distress Syndrome), and one to acute renal failure (Table III). Duration of study in Hospital is shown in Figure.2

Complications	No.	Percentage
Acute respiratory distress syndrome (ARDS)	3	5.2
Hepatitis	6	10.3
Anaphylactic shock	8	13.7
Shock	36	62.15
Rhabdomyolysis leading to Acute kidney Insult (AKI)	35	60
Seizures	2	1.9
Arrhythmia	4	6.9
Hemolysis	3	5.2
Dialysis	2	3.4
Mechanically ventilated	46	79.3
Tracheostomy	24	41

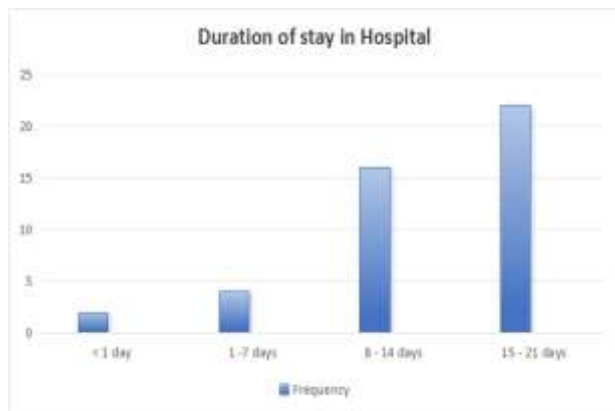


Figure 2: Duration of stay in hospital

Discussion

We report 58 cases of black stone poisoning admitted in pediatric intensive care unit. Our study is unique in reporting a significant number of pediatric cases of black stone poisoning. Most frequent cause of ingesting black stone was accidental (98.2%) which is in contrast to the other studies that reported significant numbers of suicidal and homicidal ingestion.⁷ Symptoms typically manifest within three to six hours after

ingestion, with a quicker onset indicating more severe poisoning. As documented in other studies as well, initial effects include laryngeal and cervico orofacial edema, along with respiratory distress due to direct mucous membrane toxicity. Almost All of our patients had this complication. There is no antidote specifically for PPD poisoning, so treatment primarily focuses on supportive care. In our study, mostly children were initially managed for angioedema and anaphylactic shock before the toxic substance was actually identified. This highlights the critical importance of obtaining a thorough history in cases of acute poisoning, particularly involving children.

High rate of occurrence of cervicofacial edema has also been reported in various international studies by Anugrah Chrispal et al (69.2%)⁴ and Kallel et al (79%).⁸ Asphyxia and respiratory failure are the immediate threats to life under such conditions. According to findings by Senthilkumaran et al., alveolar rupture was reported, possibly due to the air trapping resulting from intense inspiratory efforts and subsequent laryngeal edema.¹ Endotracheal intubation, emergency tracheostomy and ventilatory assistance are lifesaving. Suliman et al⁵ studied a tracheostomy rate of 15.8% in his patients while in another study tracheostomy rate was 60%. In our case tracheostomy done in 41% of cases as an emergency procedure in cases of airway edema and difficult intubation. Various studies recommend tracheostomy even there is no signs of respiratory distress at the time of examination but having features of impending laryngeal edema and asphyxia. This complication is considered disastrous following black stone ingestion.⁹

According to the literature, PPD poisoning typically presents with a characteristic trio of symptoms: early angioneurotic edema affecting the face and neck with stridor, rhabdomyolysis resulting in cola-colored urine, and acute renal failure (ARF) as supported by our study as well. These clinical manifestations can serve as definitive indicators of PPD poisoning, particularly in situations where

immediate access to laboratory tests or detailed medical history is unavailable during emergencies.^{10,11} Shock is another important clinical manifestation due to PPD poisoning which was diagnosed in 62.15% of our cases (26.3% by Kallel et al) Myocarditis, hypovolemia and sepsis might be the underlying reasons for severe hypotension. Myocardial injury and fatal cardiac arrhythmia form the basis of sudden cardiac death, which was witnessed in 2 of our patients. Hyperkalemia, with its arrhythmogenic potential can also lead to sudden death. Rhabdomyolysis and myoglobinuric ARF form the basis of hyperkalemia. 60% patients in our study had evidence for rhabdomyolysis. Kallel et al also noted rhabdomyolysis in the entire population of his study.⁸

Acute kidney insult as classified by RIFLE criteria staging occurred in 33 (57%) of our patients (47.4% by Kallel et al) out of which only 3 (5.1%) patients required peritoneal dialysis. Rest of the patients responded to conservative management like hyper hydration and forced diuresis. Figures illustrated in table 1 indicates that the majority of AKI cases in the study were at the early Risk stage, with fewer patients experiencing the more severe forms of Injury and Failure. This distribution emphasizes the importance of early detection and intervention to prevent progression from Risk to more severe stages of acute kidney injury. The lowest percentage in this stage reflects that, despite some severe cases, most AKI cases do not advance to the most critical level, suggesting that interventions are often successful in the earlier stages.¹² Black stone poisoning proved lethal in 7% children in our setup that is quite low as compared to 58.3% narrated by Akram S et al. In Bhawal victoria Hospital Bahawalpur. Likewise Akram et al described 88 cases (7.9% were children, 93.1% were adults) of PPD poisoning in Gujranwala and Sahiwal in 2018. PPD poisoning proved fatal in 29.5% cases that is comparable with international studies reporting high mortality rate of 20% (21% by Benslama et al).¹³ Mortality has been associated with dose

ingested, time to reach hospital, tracheostomy and intention of ingestion.^{14,15} Although less common, myocardial damage, myocarditis and arrhythmia are associated with higher mortality rates. In our case 50% of mortality was due to cardiac involvement.

Conclusion

- The clinical spectrum of black stone (kala pathar) ingestion in pediatric mainly include development of angioedema, rhabdomyolysis and acute kidney injury.
- Antihistamines, steroids, hydration along with diuresis were the mainstay of therapy.
- Emergency airway management in the form of endotracheal intubation or tracheostomy with or without mechanical ventilatory support, renal replacement therapy for acute kidney injury were the modalities followed for treating complications.
- Main causes of death in expired cases were cardiac arrhythmias, respiratory failure and renal failure.
- Positive outcome was associated with higher age, earlier tracheostomy and mode of poisoning.
- Raising awareness about the potential toxic effects of hair dyes, especially those containing ingredients like PPD, is crucial for public health.
- Both primary care physicians and intensive care physicians should be well-versed in recognizing the clinical manifestations of hair dye poisoning and initiating appropriate management promptly.

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