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The lungs that failed to recover: Delayed progressive lung failure following Paraquat poisoning – A fatal sequelae

Dr. Sushmitha Sudeesh[1], Dr. Preethiraj Ballal[2], Dr. Aniruddha K[3]
[1] Junior Resident, Department of Respiratory Medicine, KVG Medical College & Hospital, Sullia, Karnataka, India
[2] Associate Professor, Department of Respiratory Medicine, KVG Medical College & Hospital, Sullia, Karnataka, India
[3] Assistant Professor, Department of Respiratory Medicine, KVG Medical College & Hospital, Sullia, Karnataka, India

Abstract
Paraquat poisoning is a medical emergency associated with high mortality, primarily due to severe pulmonary toxicity. The lungs are the principal target organ, with injury ranging from acute lung injury and acute respiratory distress syndrome (ARDS) to delayed, relentlessly progressive pulmonary fibrosis. Although early survival following ingestion may create a false sense of recovery, delayed respiratory failure occurring weeks later is increasingly recognized and remains therapeutically refractory. We report a fatal case of delayed progressive lung failure presenting with platypnea–orthodeoxia syndrome six weeks after paraquat ingestion. This case underscores the distinctive pathophysiology of paraquat-induced lung injury, the paradoxical deleterious effects of oxygen therapy, diagnostic challenges in delayed presentations, and the critical need for prolonged surveillance in survivors of acute paraquat poisoning.

Keywords: Paraquat, pulmonary fibrosis, platypnea–orthodeoxia, ARDS, poisoning

Introduction
Paraquat (1,1′-dimethyl-4,4′-bipyridinium dichloride) is a highly toxic, non-selective herbicide widely used in agricultural practices, particularly in developing countries, due to its rapid herbicidal action and low cost [1]. Despite regulatory bans or restrictions in several regions, paraquat continues to be a major contributor to intentional self-poisoning, especially among young adults in rural agrarian communities [2].

Human paraquat poisoning is associated with exceptionally high mortality, with reported fatality rates ranging from 40% to over 70%, depending on the dose ingested, formulation, and time to medical intervention [3, 4]. Following ingestion, paraquat is rapidly absorbed and distributed, selectively accumulating in pulmonary tissue via energy-dependent polyamine transporters expressed on alveolar type I and type II pneumocytes [5]. This preferential pulmonary uptake explains the lungs being the principal target organ in paraquat toxicity [6].

At the cellular level, paraquat undergoes redox cycling, generating excessive reactive oxygen species (ROS) that overwhelm endogenous antioxidant defenses [7]. This results in lipid peroxidation, mitochondrial dysfunction, DNA damage, and apoptosis of alveolar epithelial cells, culminating in diffuse alveolar damage [8]. Clinically, lung injury manifests initially as acute pneumonitis or acute respiratory distress syndrome (ARDS), followed by progressive interstitial fibrosis in survivors of the acute phase [6, 9].

Delayed pulmonary toxicity is a particularly lethal feature of paraquat poisoning, as patients may show apparent clinical improvement after initial hospitalization, only to deteriorate days to weeks later due to progressive fibrotic lung disease [10, 11]. This delayed progression remains therapeutically challenging and is a major determinant of long-term mortality [12].

Case Presentation
A 37-year-old male daily wage worker from rural Karnataka presented with progressively worsening breathlessness of one-week duration. Six weeks prior, he had a history of deliberate self-harm involving ingestion of paraquat, a common method of suicide in rural South Asia. He had initially received intensive care with supportive management and was discharged following symptomatic improvement, a pattern frequently described in survivors of acute paraquat toxicity.

The current episode of breathlessness was posture-dependent, worsening on sitting or standing and improving in the supine position, suggestive of platypnea–orthodeoxia syndrome. He also complained of pleuritic chest pain without systemic symptoms, consistent with progressive parenchymal lung involvement.

Clinical Examination
On examination, the patient was emaciated with severe respiratory distress. Oxygen saturation showed significant orthodeoxia, defined as a postural drop in SpO_2 >4%, fulfilling diagnostic criteria for platypnea–orthodeoxia syndrome.Bilateral basal fine inspiratory crackles were consistent with interstitial lung disease, particularly fibrotic involvement of dependent lung zones.

Investigations
Arterial blood gas analysis demonstrated type I respiratory failure, commonly observed in paraquat-induced lung injury due to severe ventilation–perfusion mismatch. Chest radiography showed bilateral patchy alveolar infiltrates, a frequent early radiological manifestation.

HRCT thorax revealed extensive bilateral ground-glass opacities with basal predominance and areas of consolidation, suggestive of evolving fibrotic lung disease following toxic alveolitis.Echocardiography ruled out intracardiac shunts, confirming an intrapulmonary mechanism for platypnea–orthodeoxia, which has been

reported in basal-predominant lung diseases. Autoimmune causes were excluded, strengthening the causal link to paraquat toxicity.

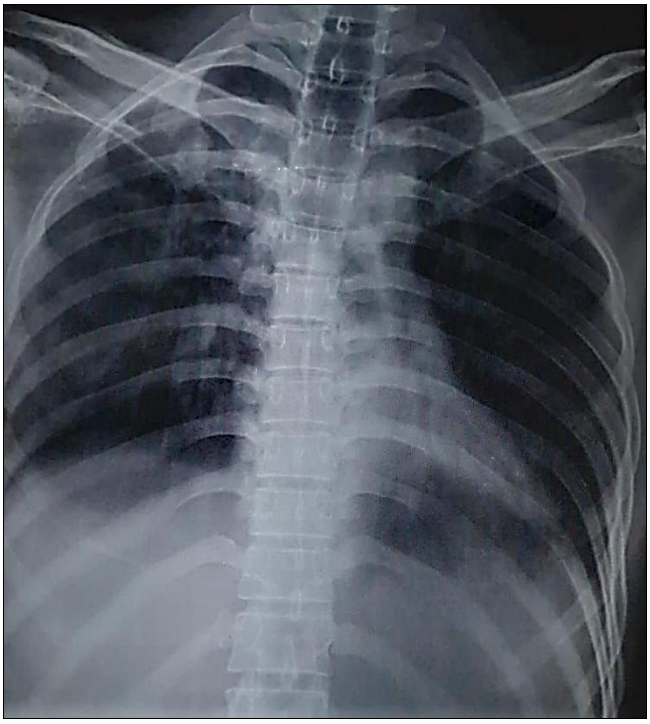

Fig 1: Chest X-ray (AP view) showing bilateral non-homogeneous patchy infiltrates predominantly involving lower zones

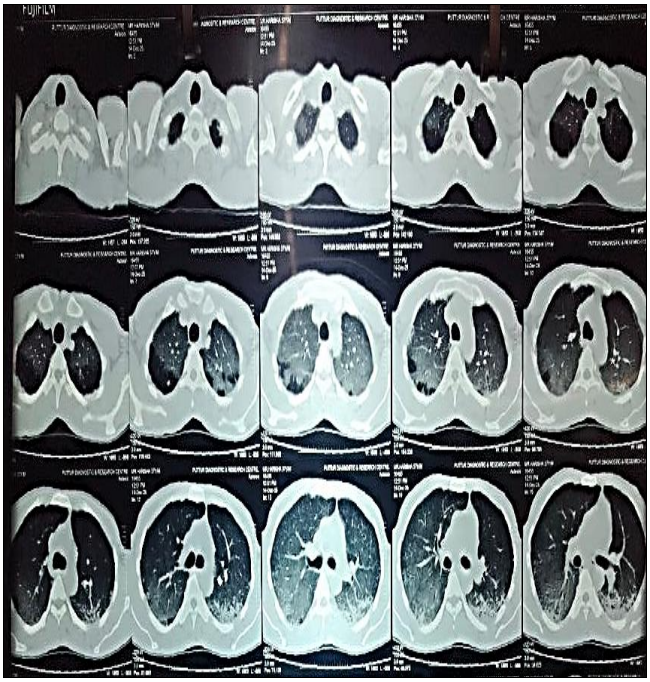

Fig 2: HRCT thorax showing extensive bilateral ground-glass opacities with basal predominance and areas of consolidation

Management and Clinical Course

The patient was managed with cautious oxygen supplementation, as high inspired oxygen concentrations are known to exacerbate paraquat-induced oxidative lung injury. Non-invasive ventilation was used with strict oxygen titration.

High-dose corticosteroids were administered to suppress inflammatory alveolitis, consistent with protocols used in moderate-to-severe paraquat poisoning. Antifibrotic therapy with nintedanib was initiated based on emerging evidence supporting its role in progressive fibrosing interstitial lung diseases, although data specific to paraquat injury remain limited. Mycophenolate mofetil was added as adjunct immunosuppression.

Despite aggressive therapy, the patient progressed to refractory hypoxemic respiratory failure, a known terminal event in advanced paraquat-induced pulmonary fibrosis.

Discussion

Paraquat-induced lung injury is primarily mediated through continuous redox cycling of the paraquat molecule, resulting in sustained production of superoxide radicals and other reactive oxygen species [7, 8]. These free radicals initiate lipid peroxidation of alveolar cell membranes, disrupt mitochondrial respiration, and trigger programmed cell death of alveolar epithelial cells [6]. The ensuing inflammatory cascade promotes fibroblast activation and excessive extracellular matrix deposition, ultimately leading to irreversible pulmonary fibrosis [9].

The lungs are uniquely vulnerable to paraquat toxicity due to preferential accumulation mediated by polyamine transport systems, resulting in pulmonary paraquat concentrations several times higher than plasma levels [5, 6]. This explains why respiratory failure remains the predominant cause of death in patients who survive the initial systemic phase of poisoning [11].

Oxygen therapy presents a therapeutic paradox in paraquat poisoning. While oxygen supplementation is often necessary to manage hypoxemia, high inspired oxygen concentrations exacerbate paraquat-induced oxidative stress by increasing free radical generation, thereby accelerating lung injury [13, 14]. Consequently, current recommendations emphasize strict oxygen restriction, reserving supplementation only for life-threatening hypoxemia [13].

Delayed pulmonary fibrosis is the principal cause of late mortality in paraquat poisoning survivors [10]. Platypnea–orthodeoxia syndrome, as observed in this patient, is an uncommon manifestation and is thought to result from posture-dependent intrapulmonary shunting due to predominant basal lung involvement, severe ventilation–perfusion mismatch, and altered pulmonary mechanics [15, 16].

Immunosuppressive regimens combining high-dose corticosteroids with cytotoxic agents such as cyclophosphamide or mycophenolate mofetil have shown variable benefit, particularly when initiated early during the inflammatory phase [4, 17]. However, once fibrotic remodeling predominates, therapeutic options are limited and outcomes remain poor despite aggressive immunosuppression or antifibrotic therapy [9, 18]. Lung transplantation has been reported in isolated cases but is rarely feasible due to systemic toxicity, psychosocial constraints, and limited availability [12].

Conclusion

Paraquat poisoning remains a major cause of toxic lung injury with high mortality, particularly in developing countries where it's agricultural use persists [1, 3]. While early survival following ingestion may suggest clinical recovery, delayed-onset pulmonary fibrosis is a well-recognized and often fatal complication [9, 11].

This case highlights the deceptive nature of paraquat toxicity, wherein patients may deteriorate weeks after

apparent stabilization due to ongoing fibrotic lung remodeling [6, 10].

Therapeutic options for delayed paraquat-induced lung injury remain limited. Although immunosuppressive strategies may offer benefit when instituted early during the inflammatory phase, their efficacy diminishes once irreversible fibrosis is established [9, 11, 18]. Oxygen therapy, while essential for managing hypoxemia, must be used judiciously due to its potential to exacerbate oxidative lung injury [12, 13].

Early recognition of progressive lung injury, cautious oxygen administration, and timely referral to specialized centers may improve outcomes, although overall prognosis remains guarded once fibrotic lung disease develops [6, 18].

References

1. Gunnell D, Knipe D, Chang SS, Pearson M, Konradsen F, Lee WJ, *et al*. Suicide by intentional ingestion of pesticides: a continuing tragedy in developing countries. Bull World Health Organ,2017:95(7):474–475.
2. Gawarammana IB, Buckley NA. Medical management of paraquat ingestion. Br J Clin Pharmacol,2011:72(5):745–757.
3. Wilks MF, Fernando R, Ariyananda PL, Eddleston M, Berry DJ, Tomenson JA, *et al*. Improvement in survival after paraquat ingestion following introduction of a new formulation in Sri Lanka. Int J Epidemiol,2014:43(6):1960–1967.
4. Smith LL. Mechanism of paraquat toxicity in lung and its relevance to treatment. Hum Toxicol,1987:6(1):31–36.
5. Dinis-Oliveira RJ. Paraquat poisonings: mechanisms of lung toxicity, clinical features, and treatment perspectives. Free Radic Biol Med,2016:99:318–330.
6. Suntres ZE. Role of antioxidants in paraquat toxicity. Toxicology,2002:180(1):65–77.
7. Bus JS, Aust SD, Gibson JE. Paraquat toxicity: proposed mechanism of action involving lipid peroxidation. Toxicol Appl Pharmacol,1976:35(3):501–513.
8. Kang MS, Gil HW, Yang JO, Lee EY, Hong SY. Comparison between early and late administration of immunosuppressive therapy in patients with paraquat poisoning. Nephrol Dial Transplant,2010:25(4):1236–1243.
9. Lin JL, Lin-Tan DT, Chen KH, Huang WH. Repeated pulse therapy with methylprednisolone and cyclophosphamide for paraquat poisoning. Clin Toxicol (Phila),2006:44(7):871–877.
10. Chen GH, Lin JL, Huang YK. Combined methylprednisolone and cyclophosphamide therapy for paraquat poisoning. Crit Care Med,2002:30(11):2584–2587.
11. Bateman DN. Pharmacological treatments of paraquat poisoning. Hum Toxicol,1987:6(1):57–62.
12. Smith P, Heath D, Kay JM. Oxygen toxicity and paraquat poisoning. Thorax,1990:45(6):437–439.
13. Dinis-Oliveira RJ, Remião F, Carmo H, Duarte JA, Navarro AS, Bastos ML, *et al*. Paraquat exposure as an etiological factor of Parkinson's disease. Toxicol Sci,2014:140(1):1–13.
14. Cheng TO. Platypnea–orthodeoxia syndrome: etiology, differential diagnosis, and management. Circulation,2002:105(4):e47–e49.
15. Agrawal A, Palkar A, Talwar A. The multiple dimensions of platypnea–orthodeoxia syndrome: a review. Chest,2017:151(3):593–603.
16. Lin NC, Lin JL, Lin-Tan DT, Yu CC. Combined continuous venovenous hemofiltration and pulse therapy in paraquat poisoning. Clin Toxicol (Phila),2011:49(2):113–119.
17. Cottin V, Wollin L, Fischer A, Quaresma M, Stowasser S, *et al*. Fibrosing interstitial lung diseases: knowns and unknowns. Eur Respir J,2022:59(3):2102571.