Multisystem Challenges in a Preterm Neonate with Perinatal hypoxia, Intracranial Hemorrhage, Bilateral Choanal Atresia, and Acute Kidney Injury: A Case Report

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Abstract
We present a male preterm neonate born at 33 weeks and 3 days gestation with multisystem diseases, including severe perinatal hypoxia, acute kidney injury (AKI), intracranial hemorrhage and bilateral choanal atresia. The case required immediate intensive care due to respiratory distress, flaccidity, and bradycardia. Postnatal imaging revealed extensive left parieto-occipital hematoma, and midline shift, necessitating antiseizure management. Bilateral choanal atresia was surgically corrected at day of life 68. AKI, secondary to hypoxic insult, required peritoneal dialysis. Although these diseases, comprehensive care including neonatology, surgery, neurology, and nephrology led to gradual improvement. By discharge (day of life 110), the case was hemodynamically stable, seizure-free, and tolerating oral feeds. This case demonstrates the importance of early diagnosis, coordinated multispecialty intervention, and long-term follow-up in improving outcomes for preterm neonates with complex Challenges.
Key words: Preterm Neonate, Perinatal hypoxia, Acute Kidney Injury, Bilateral Choanal Atresia, Intracranial Hemorrhage.

Introduction

One in ten newborns is born prematurely, at below thirty-seven weeks of gestation. **(1)** Preterm birth and its associated consequences are the primary contributors to infant morbidity and mortality in the US.**(2)** Other perinatal disorders, including hypoxic-ischemic encephalopathy (HIE).**(3)** Perinatal HIE remains as a primary etiology of neonatal brain injury.**(4)** Intracranial bleeding is a primary contributor to negative neurological outcomes in babies, as it impacts the developing brain throughout a critical phase of structural and functional maturation.**(5)** In term newborns, intracranial hemorrhage primarily arises throughout birth because of mechanical trauma, but in preterm infants, it is likely attributable to hemodynamic instability and the vulnerability of the germinal matrix (GM) vasculature.**(6)**

Intraventricular hemorrhage (IVH) is the predominant short-term neurological symptom and remains a significant issue associated with preterm. **(7)** As the survival rate of preterm newborns rises, the prevalence of intraventricular hemorrhage becomes more significant. Moreover, it worsens the risk of mortality and both short- and long-term neurodevelopmental impairments. **(8)**

Acute Kidney Injury is defined by a sudden decline in renal function due to multiple underlying factors. Neonatal AKI is classified as 'early-onset', occurring within the first seven days post-birth, or 'late-onset', happening following seven days post-birth. **(9)**

Choanal atresia (CA) is an uncommon congenital defect marked by bilateral or unilateral anatomical obstruction of the posterior nasal aperture. **(10)** Bilateral congenital anomalies result in acute postnatal respiratory distress needing intubation. Given the significant morbidity associated with extended intubation and sedation in neonates, early surgical intervention is essential to facilitate extubation. **(11)**

Case presentation

A male preterm neonate born at 33 weeks and 3 days gestation by emergency lower segment cesarean section (LSCS) due to breech presentation and maternal history of previous cesarean delivery. His birth weight was 2.180 kg, and he has been admitted to the neonatal intensive care unit (NICU) immediately following delivery due to severe respiratory distress, flaccidity, and bradycardia. By discharge on 15/12/2024 (at day of life (DOL) 110), he weighed 3.500 kg.

Antenatal history: His mother is a 40-year-old multiparous woman (G6P3+2+1+6) with poorly controlled type II diabetes mellitus on insulin, prolonged preterm premature rupture of membranes (PPROM) for 2 months, and a urinary tract infection caused by *Escherichia coli*. Antenatal steroids were completed, and maternal CRP was elevated.

Following delivery, the infant required extensive resuscitation, including positive pressure ventilation (PPV) with endotracheal intubation and surfactant administration (Survanta) within 3 hours of life. He developed respiratory distress syndrome (RDS III), necessitating oscillatory ventilation (HFOV) and later synchronized intermittent mandatory ventilation (SIMV). His respiratory course was further complicated by bilateral choanal atresia, diagnosed after failed nasogastric tube placement. Surgical correction was performed at day of life 68, followed by stent removal at day of life 100. Postoperatively, he has been extubated to room air by day of life 73 but remained on nebulized Pulmicort and Atrovent for bronchopulmonary dysplasia (BPD).

The infant's neurological complications stemmed from severe perinatal hypoxia, evidenced by cord blood gas showing pH 7.07, base excess -16.9, and elevated serum lactate (10.2 mmol/L). Imaging revealed significant intracranial pathology: initial head ultrasound (Figure1,2) demonstrated a left parieto-occipital hematoma (30x15 mm) with cerebellar hemorrhages, while subsequent MRI (Figure 3) and CT confirmed a 5x4.6x3 cm left parieto-occipital hematoma, midline shift (4 mm), subarachnoid hemorrhage, and germinal matrix hemorrhages. He experienced recurrent myoclonic seizures starting at day of life 9, managed with phenobarbitone and later transitioned to levetiracetam (Keppra). An electroencephalogram (EEG) at day of life 87 showed no epileptiform activity, and seizures remained controlled at discharge.

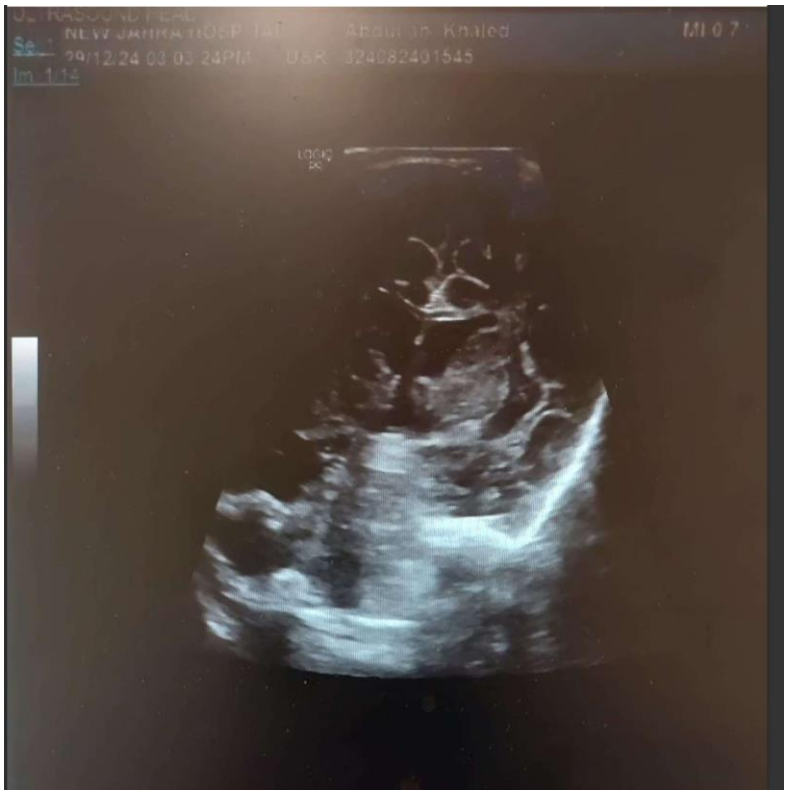

Figure 1: Ultrasound shows a coronal view of the brain. There is significant echogenicity within the brain parenchyma, consistent with parenchymal and intraventricular hemorrhage.

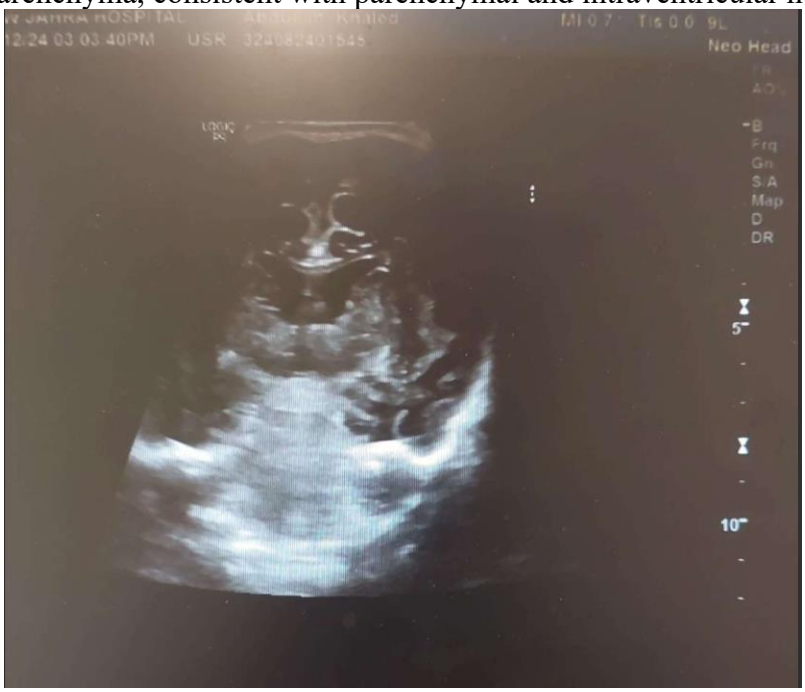

Figure 2: Ultrasound shows a sagittal view. Demonstrate the very bright appearance of the cortical and periventricular regions, consistent with significant hemorrhage.

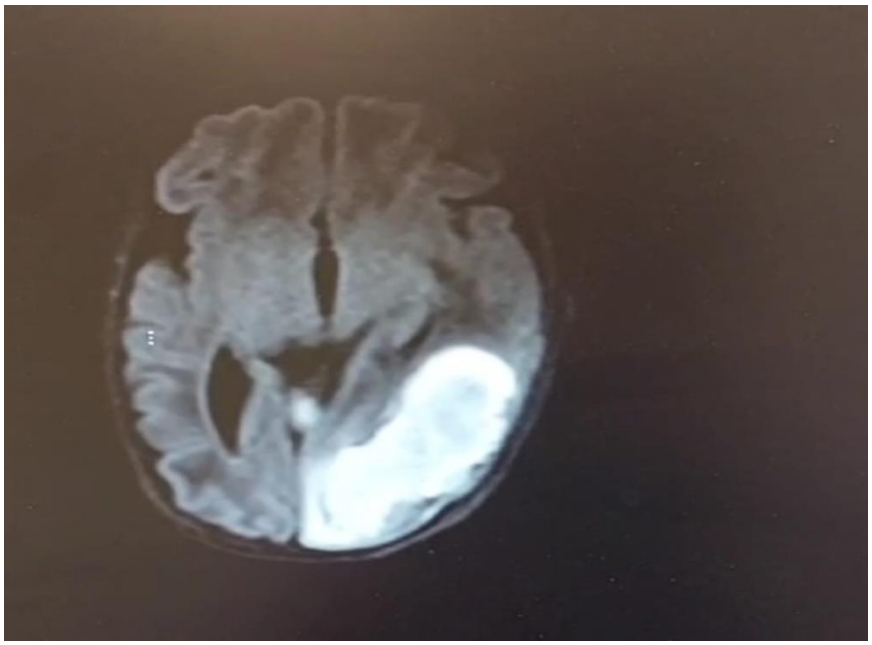

Figure 3: This MRI image provides strong visual evidence of the subacute. The large left parieto-temporo-occipital lesion with mass effect is significant.

Acute kidney injury (AKI) developed secondary to hypoxic insult, marked by oliguria, hyperkalemia (6.2 mEq/L), hyponatremia (125 mEq/L), and rising creatinine (peak 316 µmol/L). Peritoneal dialysis was initiated on day of life 5 and continued until DOL 17, with gradual improvement in renal function (discharge creatinine: 81 µmol/L). Hepatic involvement included cholestasis and markedly elevated transaminases, managed with ursodeoxycholic acid and hepatoprotective formulas.

Infectious complications included thrombocytopenia and coagulopathy attributed to sepsis, with blood cultures positive for *Staphylococcus epidermidis*. He received teicoplanin and renal-adjusted antibiotics, alongside fresh frozen plasma and vitamin K for coagulopathy. Persistent thrombocytopenia prompted hematology consultation, though no platelet antigen abnormalities were identified.

At discharge, the infant was hemodynamically stable, seizure-free on Keppra, and tolerating oral feeds. Follow-up plans included ENT surveillance for choanal atresia, neurosurgical monitoring of intracranial hemorrhage resolution, repeat EEG, and early intervention programs (EIP) for physiotherapy and developmental support.

Follow-up: revealed a completely normal examination in the neonatal OPD, with the baby also demonstrating a normal neurological assessment in the neurology OPD, including no convulsions. In nephrology, renal function tests were normal, alongside good urine output, while hematology results showed resolution of thrombocytopenia and a normal CBC. Laboratory follow-up confirmed platelets at 291 ($\times 10^3/\mu L$), creatinine at 88 (µmol/L), and urea at 5.8 (mmol/L), all within normal ranges, indicating stable and healthy outcomes across all specialties.

Discussion

This case highlights a rare and complex presentation involving perinatal hypoxia, intracranial hemorrhage, bilateral choanal atresia, and acute kidney injury in a preterm neonate. The patient's favorable outcome emphasizes the importance of timely multidisciplinary care.

Concerning perinatal hypoxia and intracranial hemorrhage: Severe perinatal hypoxia is a recognized risk factor for neonatal brain injury. While germinal matrix hemorrhages are common in preterm infants, the extent of the hemorrhagic involvement observed in this case, including a large left parieto-occipital hematoma (5x4.6x3 cm) and cerebellar hemorrhages, is rare. Early imaging and seizure management with phenobarbitone and subsequent levetiracetam (Keppra) likely contributed to the infant's favorable neurological outcome.

Consistent with our results, **Leijser LM et al. (12**) revealed that germinal matrix hemorrhage and intraventricular hemorrhages (GMH-IVH) persist as a prevalent and clinically relevant issue in preterm infants, especially those who are extremely preterm. A significant GMH-IVH frequently leads to posthemorrhagic ventricular dilatation (PHVD) or parenchymal hemorrhagic infarction and is related to a heightened risk of negative neurological sequelae.

Although cerebral hemorrhages and acute renal injury are acknowledged consequences of prenatal hypoxia, the degree and severity observed in this newborn are uncommon. Early peritoneal dialysis effectively addressed acute kidney injury, corroborating recent findings on the advantages of timely renal management. **Coe K et al. (13)** reported a case of a neonate who developed acute renal failure following a subgaleal hemorrhage and discussed the treatment of ARF with peritoneal dialysis. They established that acute renal failure in the neonatal intensive care unit is prevalent and potentially reversible, with successful treatment dependent upon early recognition. Acute renal failure must be anticipated in both premature and term newborns, particularly following substantial blood loss, like in cases of subgaleal hemorrhage or other ischemic events. Oliguria or anuria are late indicators of acute renal failure, and early detection prior to their onset is essential for optimal outcomes. Peritoneal dialysis may serve as a treatment for acute renal failure, particularly when renal recovery is expected.

Moreover, bilateral choanal atresia, a life-threatening airway obstruction, posed significant respiratory challenges. Failure of nasogastric tube placement prompted its diagnosis **(14)**, which aligns with diagnostic approaches reported in literature. Surgical correction at day of life 68 followed by stent removal at day of life 100 significantly improved respiratory stability, leading to extubation by day of life 73.

Furthermore, this was concordant with, **Zaidi A et al., (15)** who revealed that bilateral choanal atresia (CCA) requires a high index of suspicion in preterm neonates with respiratory distress disproportionate to oxygen and ventilator needs. The failure to pass a size five French nasogastric tube through the nasal cavity was a key diagnostic clue. As noted in previous literature, CT imaging played a pivotal role in confirming the diagnosis and guiding surgical planning. The successful correction in this case highlights the growing preference for the endoscopic transnasal approach, known for improved visualization, reduced morbidity, and higher success rates.

Furthermore, **Saleem AF et al. (16)** indicated that bilateral CCA is both a recognized and uncommon newborn emergency. It is essential to preserve the airway until the corrective operation is performed. It was proposed that either the unsuccessful rupture of the buccopharyngeal membrane or the abnormal migration of neural crest cells into the nasal vault leads to choanal atresia.

In this case study, a key challenge was the timely diagnosis of intracranial hemorrhage and AKI. Multimodal imaging, including head ultrasound, CT, and MRI, was essential in assessing the extent of cerebral injury and guiding management strategies.

This aligns with **Heit JJ et al. (17)**, who conducted a review of magnetic resonance imaging and CT assessments of cerebral bleeding to provide a comprehensive overview of its many sources and manifestations. They established that intracerebral hemorrhage is a critical medical occurrence with elevated fatality rates. The imaging characteristics of intracerebral hemorrhage exhibit significant variability, indicative of the diverse pathologies that lead to intracerebral hemorrhage. Thorough analysis of the intracerebral hemorrhage pattern, case symptoms and demographics, along with relevant vascular or post-contrast imaging, can often establish the diagnosis.

Finally, in the current case, initial seizure management with phenobarbitone was inadequate, prompting a transition to levetiracetam, which successfully controlled seizures without relapse as confirmed by a normal EEG on day of life 87. The infant developed sepsis with thrombocytopenia and coagulopathy, which required the use of teicoplanin and renal-adjusted antibiotics. Fresh frozen plasma and vitamin K were administered to correct coagulopathy, leading to stabilization.

In contrast to the research carried out by **Gupta SN et al. (18)**, it has been stated that the management of a critically ill neonate in the neonatal intensive care unit commences with the confirmation of an intracranial hemorrhage diagnosis. Any treatable etiological cause (e.g., dehydration, sepsis, vitamin K insufficiency, thrombocytopenia, or coagulopathy) must be recognized and treated promptly.

Conclusion

This case highlights the complexity of managing a preterm neonate with multiple, concurrent challenges, including perinatal hypoxia, acute kidney injury, intracranial hemorrhage, and bilateral choanal atresia. Early diagnosis, appropriate interventions, and a multidisciplinary approach were critical in managing this case. Despite the severity of the complications, appropriate medical management, including seizure control with levetiracetam, effective infection treatment, and renal support through peritoneal dialysis, contributed to a positive outcome. This case highlights the importance of early intervention, continuous monitoring, and individualized care in improving the prognosis of preterm neonates with multisystem involvement. Long-term follow-up, including neurological and developmental assessments, are crucial for ensuring appropriate recovery and development.

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