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EFFECT OF EARLY PHYSIOTHERAPY INTERVENTION ON DEVELOPMENTAL OUTCOMES IN AN INFANT WITH MECONIUM ASPIRATION SYNDROME AND HYPOXIC-ISCHEMIC ENCEPHALOPATHY: A CASE STUDY.

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ABSTRACT Hypoxic-ischemic encephalopathy (HIE) and meconium aspiration syndrome (MAS) can cause severe neurodevelopmental delays. This case study examines the impact of early physiotherapy in an infant with MAS and HIE presenting with global developmental delay. Motor delay, hypotonia, respiratory congestion, and feeding difficulties were among the initial findings. Chest physical therapy, neurodevelopmental therapy, sensory integration, and carer education were all included in an eight-week program. With GMFM-88 scores rising from 28% to 54% after the intervention, the baby demonstrated significant functional improvement in respiratory status, motor skills, feeding coordination, and social interaction.

KEYWORDS :

INTRODUCTION

Neonatal medicine continues to face considerable challenges in addressing conditions that significantly impact both immediate survival and long-term quality of life. Among these, Meconium Aspiration Syndrome and Hypoxic-Ischemic Encephalopathy stand out as two of the most critical conditions affecting term and near-term infants. Both disorders, although differing in etiology and primary systems affected, are strongly linked through their potential to produce long-term neurodevelopmental complications, particularly Global Developmental Delay.[1]

MAS is a respiratory disorder occurring when neonates inhale meconium-stained amniotic fluid during intrauterine gasping or immediately after delivery. The aspirated meconium can result in persistent pulmonary hypertension.[2] Infants with severe MAS often require prolonged neonatal intensive care and those with associated hypoxia are at increased risk of developing neurological sequelae.[5] Hypoxic-Ischemic Encephalopathy remains a major contributor to neonatal mortality and long-term disability.[3] HIE results from a critical reduction in cerebral blood flow and oxygenation, most frequently caused by perinatal asphyxia, placental abnormalities or complications during labor such as prolonged fetal bradycardia, cord prolapse. Initially, hypoxia and ischemia cause primary energy failure, leading to depletion of ATP and failure of ion pumps.[3] This is followed by a latent phase, in which partial recovery occurs, but is soon succeeded by secondary energy failure due to excitotoxicity, oxidative stress, inflammation, and apoptosis.[4] The extent of brain injury depends on the severity and duration of hypoxia as well as the infant's compensatory responses. Clinical outcomes range from mild developmental delays to profound cerebral palsy, epilepsy and intellectual disability.[4] A significant proportion of infants who survive MAS and HIE develop Global Developmental Delay (GDD), defined as a significant lag in two or more developmental domains. Children with GDD often present with hypotonia, poor postural control, delayed acquisition of motor milestones such as sitting and walking, and impaired communication skills. In this continuum from acute neonatal insult to chronic developmental disability, physiotherapy plays an indispensable role. In immediate neonatal period, physiotherapists contribute to respiratory management in MAS through airway clearance techniques, gentle chest physiotherapy, positioning and facilitation of oxygenation. Techniques like oromotor stimulation enhance feeding efficiency and sucking-swallowing coordination, reducing the risk of aspiration and ensuring nutritional adequacy.[5] Early intervention programs are designed to facilitate age-appropriate milestones and prevent secondary complications. Approaches such as neurodevelopmental treatment (NDT), sensory integration and task-specific motor training are employed to improve trunk control, postural stability and functional mobility. Sensory stimulation techniques, enhance overall sensory awareness and motor planning.[5]

Case Presentation

A male baby was born on 29th January 2025, with both parents in a consanguineous marriage of 20 years. Consent was obtained from the mother for the report. The mother's antenatal history was significant for persistent vomiting throughout pregnancy. The infant was delivered through normal vaginal delivery, with a birth weight of 2.95 kg. The baby had a late cry and birth asphyxia was noted, immediately after birth. The infant was diagnosed with severe MAS and was shifted to the NICU for stabilization. Postnatally, the infant was unable to breastfeed adequately due to insufficient maternal breast milk supply and required assisted feeding. Following discharge, the infant remained hemodynamically stable but continued to present with recurrent cough. On 19th August 2025, at the chronological age of 7 months, the infant was referred to the Department of Paediatric Physiotherapy with the chief complaint of delayed developmental milestones and cough. According to the mother, the infant was unable to prone on elbows, crawl, or attain tripod sitting compared to peers of the same age. Developmental assessment revealed a developmental age of 4 months. At the follow-up at 8 months, the child still had not attained prone progression, crawling, or tripod sitting. Social and language skills were also observed to be delayed.

Examination

The infant was examined in a quiet and well-lit clinical setting. The child was conscious and cooperative during the evaluation. Informed consent was obtained from the mother before starting the assessment. The infant established good eye contact and responded to auditory cues but showed reduced awareness of the surroundings and limited spontaneous interaction with the environment.

Table No.1 Developmental Milestone Assessment

Developmental Domain	Milestone	Typical Developmental Age	Child's Current Status / Chronological Age
Gross Motor Development	Head control	6 weeks	3 months
	Rolling	4–6 months	Not attained (7 months)
	Sitting with support	5–7 months	Not attained
	Tripod sitting	7–8 months	Not attained
	Prone on hands	6–7 months	Not attained
	Crawling	9–11 months	Not attained
	Standing with support	9–12 months	Not attained
Fine Motor Development	Grasp reflex	0–3 months	Poor
	Reach for objects	2–4 months	Poor
	Mouthing	3–6 months	Absent

	Transfer object	4–6 months	Not attained
	Voluntary grasp	6–8 months	Not attained
	Purposeful release	7–9 months	Not attained
Social and Language Development	Social smile	4–6 weeks	Present
	Recognition of mother	6 months	Present
	Response to sound	6–7 months	Present
	Eye contact	6–7 months	Present

Physiotherapy Intervention

Problem List	Physiotherapy Goals	Treatment / Interventions	Dosages
Retention of secretions	To reduce pulmonary secretions and improve airway clearance	Chest physiotherapy (percussion, vibration)- Postural drainage/positioning- Nebulizer therapy- Steam inhalation	Percussion: 5–10 min, 2–3×/day- Postural drainage: 10–15 min, 2–3×/day- Nebulizer: As prescribed (e.g. 2.5 mg albuterol or saline)- Steam inhalation: 10 min, 1–2×/day
Increased muscle tone	Improve trunk stability; prepare for crawling & sitting balance	Tummy time with bolster- Guided rolling transitions- Supported sitting on wedge/therapy ball- Facilitation of quadruped position	Tummy time: 10–15 min, 3–4×/day- Rolling: 5–10 reps/session- Supported sitting: 5–10 min, 2–3×/day
Difficulty in trunk control	To improve trunk control and antigravity strength	Supported sitting with trunk facilitation- Side-lying to sitting transitions- Balance activities on therapy ball	10–15 min per session, 2–3×/day
Impaired balance and postural control	Enhance postural adjustments and protective reactions	Weight-shifting in supported sitting- Facilitation of tripod sitting- Dynamic reaching tasks in supported positions	5–10 min, 2–3×/day
Impaired oromotor skills	Stimulate oral reflexes and improve mouthing/feeding	Oral stimulation with safe teething toys- Facilitated mouthing activities- Orofacial stimulation (tongue, jaw)	5 min, 2–3×/day
Delayed gross motor milestones	Encourage age-appropriate motor development through tone normalization and improved postural alignment.	Prone on elbows → prone on hands- Assisted rolling (supine ↔ prone)- Supported → tripod sitting- Crawling preparation in quadruped	Prone: 5 min/session, 2×/day- Rolling: 10 reps/session- Sitting: 5–10 min, 2–3×/day
Delayed fine motor skills	Improve hand-eye coordination and voluntary grasp/release	Reaching activities (midline and lateral)- Grasping rattles, blocks- Training voluntary release into containers	Reaching: 5–10 min/session- Grasp: 5 min, 2–3×/day- Release: 5–10 min, 2–3×/week
Caregiver knowledge gap	Empower caregiver with home-based stimulation skills	- Parent education: handling & positioning- Daily tummy time & toy play- Interactive play (singing, eye contact)- Home program demonstration	- Tummy time: 10–15 min, 2–3×/day- Play routines: 15–20 min- Interactive play: 10–15 min
Sensory stimulation needs	Enhance sensory integration, arousal regulation, and awareness of environment	- Tactile stimulation (massage with varied textures, brushing)- Vestibular input (gentle rocking, swinging)- Visual stimulation (tracking toys, contrasting colors)- Auditory stimulation (bells, rattles, soothing music)- Proprioceptive input (joint compression, weight-bearing play)	- 5–10 min, 2–3×/day per sensory modality- Adjust based on child's tolerance

Outcome Measures

Outcome measures	Pre- treatment	8 weeks follow-up
GMFM – 66	44.6%	79.2%
Functional Communication Classification System	Grade 4	Grade 3
GMFCS	Level 4	Level 2
BFMF	Level 2	Level 2

RESULTS

After eight weeks of structured physiotherapy, infant demonstrated significant improvement across respiratory, motor, sensory and social domains. Respiratory congestion and coughing reduced with improved oxygen saturation, feeding tolerance and sleep quality.

Motor development progressed notably, with attainment of stable head control, brief independent prone-on-elbows positioning, partial rolling and short-duration supported sitting. Trunk and upper limb muscle tone improved, with mild residual hypotonia in the lower limbs. GMFM-88 scores increased from 28% to 54%, indicating meaningful gains in prone and sitting abilities.

Fine motor and oromotor functions also improved, including voluntary grasp, midline reaching, better hand opening, coordinated sucking and swallowing and reduced drooling. Sensory integration interventions enhanced visual tracking, balance reactions and environmental responsiveness.

Caregiver education and adherence to the home program contributed significantly to sustained progress and improved social interaction. Developmental age advanced from four to approximately six months at a chronological age of eight months, with better eye contact and early vocalizations observed.

DISCUSSION

This case presents an infant diagnosed with MAS complicated by HIE, leading to GDD. The interplay of respiratory insufficiency and hypoxic brain injury underscores the multifactorial nature of delayed neurodevelopment in neonates with MAS and HIE. Both conditions disrupt oxygen delivery to critical brain areas such as the basal ganglia and thalami, impairing motor and cognitive functions. The clinical picture was characterized by delayed motor milestones, poor postural control, hypotonia and deficient oromotor coordination all consistent with GDD resulting from hypoxic insult.

Physiotherapy interventions in this case targeted respiratory clearance, neuromotor development and sensory regulation. Early initiation of chest physiotherapy effectively reduced pulmonary congestion, while neurodevelopmental treatment and sensory integration approaches improved postural control, balance and motor coordination. Progressive improvement in GMFM and Functional Communication Classification reflected measurable functional gains after eight weeks of structured rehabilitation. Importantly, parent education and home-based play therapy reinforced therapeutic continuity, aligning with evidence that caregiver engagement significantly enhances long-term developmental outcomes.

Combining conventional physiotherapy with sensory integration appears particularly beneficial in improving attention, coordination and environmental responsiveness in neurologically compromised infants.

CONCLUSION

The case highlights that early, individualized and multidisciplinary physiotherapy interventions can substantially improve developmental

outcomes in infants affected by MAS and HIE. The integration of airway clearance, neurodevelopmental facilitation, sensory integration and active caregiver participation led to measurable progress in gross and fine motor domains, oromotor control and social responsiveness. The improvement in GMFM and GMFCS levels demonstrates that consistent therapy can promote neuroplasticity even in severe neonatal conditions. Ultimately, this case reinforces the necessity of early identification, prompt physiotherapeutic management and quality of life in infants with hypoxic-ischemic and respiratory complications

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