Six-Month Neurodevelopmental Outcomes in Survivors of Perinatal Asphyxia: A Prospective Cohort Study from North India

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Abstract:
Background: Perinatal asphyxia is a major cause of neonatal mortality and long-term neurodevelopmental morbidity. While in-hospital outcomes are well documented, limited Indian data exist on medium-term sequelae in survivors.
Objective: To assess neurodevelopmental outcomes at six months in term neonates who survived perinatal asphyxia and to identify associated clinical predictors.
Methods: This prospective observational cohort was conducted at the G.B. Pant Hospital, Srinagar, from November 2017 to April 2019. Term neonates (≥37 weeks, >1.8 kg) with Apgar <6 at 5 min and features of hypoxic ischemic encephalopathy (HIE) were enrolled. Survivors were followed up to six months for developmental assessment, seizure occurrence, and neurological status. Associations with baseline demographic, maternal, and intrapartum variables were analyzed using chi-square or Fisher's exact test.
Results: Of 217 enrolled neonates, 186 (85.7%) survived to discharge; 90 (48.4%) were followed up at six months. Normal development was observed in 22 (11.8%) infants, seizures with normal development in 18 (9.7%), and seizures with developmental delay in 50 (26.9%). Higher HIE grade was strongly associated with adverse outcomes ($p<0.001$). Unbooked maternal status, prolonged labor, and delayed hospital arrival (>5 h) were significant predictors of developmental delay.
Conclusion: Over one-third of survivors of perinatal asphyxia had seizures with developmental delay by six months. HIE grade, perinatal complications, and delayed referral were significant risk factors. Strengthened follow-up programs and early intervention services are warranted.

INTRODUCTION

Perinatal asphyxia is defined as an impairment of gas exchange leading to hypoxemia and hypercapnia, often accompanied by metabolic acidosis. It remains a significant cause of neonatal mortality and morbidity worldwide, especially in low- and middle-income countries, where access to skilled birth attendants and advanced neonatal care is limited (World Health Organization, 2020)[1]. Globally, it accounts for nearly one million neonatal deaths each year and is a major contributor to long-term neurodevelopmental disabilities (Lawn et al., 2005)[2].

The clinical syndrome most commonly resulting from perinatal asphyxia is hypoxic ischemic encephalopathy (HIE), graded according to the Sarnat and Sarnat classification (Sarnat & Sarnat, 1976)[3]. Numerous studies have shown a direct correlation between HIE severity and the risk of mortality or neurodevelopmental impairment (Thornberg et al., 1995[4]; Padyachee & Ballot, 2013[5]; Laptook et al., 2009[6]).
In India, despite improvements in institutional delivery rates, perinatal asphyxia remains a major challenge

due to delays in referral, inadequate intrapartum monitoring, and limited follow-up services (Nazeer et al., 2017)[7]. Long-term follow-up studies are scarce, particularly from the northern region, including Kashmir, where geographical and infrastructural barriers may compound risks. Early identification of at-risk infants allows timely referral to neurodevelopmental therapy and rehabilitation services (Nair et al., 2014)[8]. This study was undertaken to fill the gap in literature by prospectively assessing six-month neurodevelopmental outcomes and their predictors in survivors of perinatal asphyxia in a high-burden tertiary care setting.

METHODS

Study design and setting: Prospective observational study at G.B. Pant Hospital, Government Medical College, Srinagar, between November 2017 and April 2019.
Inclusion criteria: Term neonates (≥37 weeks), birth weight >1.8 kg, Apgar score <6 at 5 min, features of HIE (Sarnat staging).
Exclusion criteria: Major congenital malformations, chromosomal abnormalities, conditions incompatible with life, preterm neonates.
Follow-up protocol: Survivors were assessed at discharge and scheduled for follow-up visits at 6 weeks, 3 months, and 6 months. Neurodevelopmental assessment included CDC motor milestones, Trivandrum Development Screening Chart, and seizure history.
Data analysis: SPSS v20.0 was used. Associations between outcome categories and predictors were tested using chi-square/Fisher's exact test. $p<0.05$ was significant.

RESULTS

Baseline characteristics: Of 217 neonates, 171 (78.8%) had HIE; 50 (29.2%) Grade I, 94 (55.0%) Grade II, 27
(15.8%) Grade III.
Survival and follow-up: 186 (85.7%) survived to discharge. Follow-up at 6 months was available in 90 (48.4%) survivors; 96 (51.6%) were lost to follow-up.
Neurodevelopmental outcomes: Normal development: 22 (11.8%), Seizures with normal development: 18 (9.7%), Seizures with developmental delay: 50 (26.9%).
Association with HIE grade: Adverse outcomes increased with HIE severity ($p<0.001$).
Predictors of adverse outcome: Unbooked maternal status ($p=0.02$), prolonged labor ($p=0.03$), arrival to tertiary care >5 h after birth ($p=0.01$).

Table 1: Neurodevelopmental outcomes at six months follow-up

Outcome	Frequency (n)	Percentage (%)
Normal development	22	11.8
Seizures with normal development	18	9.7
Seizures with developmental delay	50	26.9
Lost to follow-up	96	51.6

Table 2: Association of neurodevelopmental outcomes with HIE grade

HIE Grade	Normal / Seizures no delay	Seizures + Delay	p-value
Grade I	Predominantly normal	Few	<0.001
Grade II	Some normal	High proportion	<0.001
Grade III	Rare	Predominantly delay / death	<0.001

DISCUSSION

Our findings show that 26.9% of survivors exhibited seizures with developmental delay at six months, which is consistent with rates reported by Agarwal et al. (2008)[9] and Yelamali et al. (2014)[10]. The strong association between HIE grade and adverse neurodevelopmental outcome mirrors previous reports by Ilah et al. (2015)[11], reinforcing the prognostic value of early neurological staging.

The high proportion of unbooked mothers and prolonged labor among affected neonates suggests preventable obstetric risk factors. Strengthening antenatal care coverage and timely intrapartum referral could potentially reduce the incidence of severe HIE. Similar observations have been made in studies from other developing countries where resource constraints impact timely care (Padyachee & Ballot, 2013)[5].

Loss to follow-up in more than half the survivors is a limitation, raising the possibility of underestimation of true morbidity. Nevertheless, this highlights the urgent need for institutionalized follow-up clinics, parental counseling, and integration of neurodevelopmental screening into routine pediatric visits (Nair et al., 2014)[8].

Future research should focus on larger multicentric cohorts, longer follow-up periods, and interventional strategies such as early physiotherapy, occupational therapy, and seizure control to improve long-term quality of life.

CONCLUSION

Over one-third of survivors of perinatal asphyxia in our cohort developed seizures with developmental delay by six months. HIE severity, perinatal complications, and delayed referral were significant predictors. Early detection and intervention programs are critical to improving long-term outcomes.

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