Lead Article

Predictability of INFANIB and Amiel-Tison Neuromotor Assessments in the Follow-Up of High-Risk Neonates

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Abstract

Background and Aims: Neurologic assessment forms an integral part of follow-up of high-risk neonates. The available assessment methods have their own advantages and disadvantages.

The primary objective was to compare the predictability of Infant Neurological International Battery (INFANIB) and Amiel-Tison methods of neuromotor assessment with that of Developmental Assessment Scale for Indian Infants (DASII). The secondary objective was to determine the neurodevelopmental outcomes of neonates weighing < 1800 g at birth.

Materials and Methods: Neonates with birth weight < 1800 g at 40 weeks corrected age were enrolled. All participants were assessed both by INFANIB and Amiel-Tison methods at 40 weeks corrected age and 3, 6, 9, and 12 months corrected ages, by 2 different investigators. All infants were assessed by DASII at 12 to 15 months by a trained child psychologist. Data were statistically analyzed.

Results: Amiel-Tison method showed a higher sensitivity and specificity at 40 weeks corrected age for identifying infants with low motor developmental quotient (< 70). INFANIB method showed better sensitivity at 3, 6, 9, and 12 months corrected ages. Both the methods had a high negative predictive value (> 90%). Only 3 infants had a developmental quotient < 70

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at 12 months corrected age. The mean motor and mental developmental quotients were 97.87 ± 21.8 and 89.64 ± 11.5, respectively.

No neonatal risk factor was significantly associated with abnormal neurologic outcome. In 69% infants, transient neurologic abnormalities were detected by INFANIB, which normalized by 1 year.

Conclusions: INFANIB may be a good screening tool in early infancy and Amiel-Tison may be useful for confirming the neurologic abnormality. The developmental outcome of neonates with birth weight < 1800 g was good, with 93% being normal at 1 year.

Key Words: INFANIB, Amiel-Tison, DASII, low birth weight, motor developmental quotient, mental developmental quotient

Introduction

With improving survival rates of low-birth-weight neonates, more numbers of them have to be evaluated for neurologic sequelae. Although sophisticated techniques are available to assess the neonatal brain, clinical examination of the developing brain is crucial for early detection of neurologic abnormalities and prognosis. However, there is no consensus on the choice of the method of neurologic assessment; it depends on the purpose, feasibility, and the clinician's preference.[1-4] A method that has high sensitivity and specificity to predict and distinguish between normal and abnormal would be ideal.

The Amiel-Tison neurologic assessment is simple and practical for the neonatologist[5] and is routinely used in our high-risk follow-up clinic. The Infant Neurological International Battery (INFANIB) is a screening tool devised by Patricia Ellison.[6] It is based on 20 items and has components from different neuromotor assessment scales such as Amiel-Tison, Vojta, Milani-Comparetti, and Gidoni methods.[7]

Aims

1. To compare the accuracies of INFANIB and Amiel-Tison methods with Developmental Assessment Scale for Indian Infants (DASII) in predicting the neurological and developmental outcomes of high-risk neonates
2. To determine the neurodevelopmental outcomes in neonates weighing < 1800 g at birth

Materials and Methods

This prospective blinded analytical study was conducted in the follow-up clinic attached to a level-3 neonatal intensive care unit (NICU) of St. John's Medical College Hospital (Bengaluru, Karnataka, India), over a period of 27 months. Approval from the institutional ethics committee was sought. Prospective study participants were identified during the hospital stay and the parents were sensitized regarding the importance of neurodevelopmental follow-up.

A total of 60 neonates at 40 weeks corrected age, with birth weight < 1800 g, presenting to our neonatal follow-up clinic were selected for the study after obtaining informed parental consent. As some parents were unable to bring their children for follow-up at the specified time and for DASII study, 11 of them were excluded. Hence, of the 60 neonates selected, 49 completed the study (Figure).

Comprehensive multidisciplinary follow-up services were provided in the neonatal follow-up clinic by neonatologists, audiologists, otorhinolaryngologists, child psychologists, occupational therapists, and

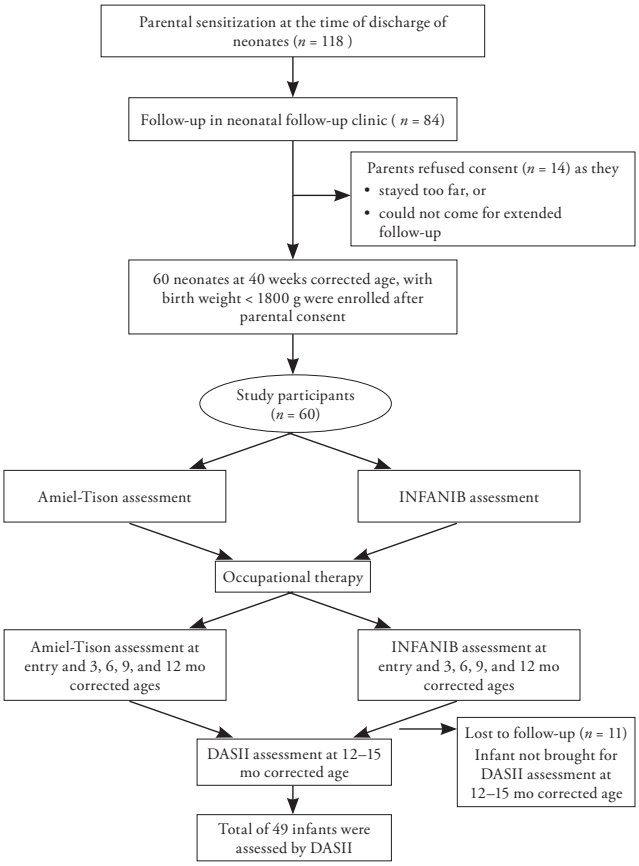

Figure. Study Flowchart
DASII, Developmental Assessment Scale for Indian Infants; INFANIB, Infant Neurological International Battery.

lactation specialists. The risk factors for adverse neurodevelopmental outcomes were assessed from the discharge reports.

Neurologic assessments were performed at 40 weeks corrected age and then at 3, 6, 9, and 12 months corrected ages. All participants were assessed both by Amiel-Tison and INFANIB methods by 2 different investigators; the investigators were blinded.

Each item in the Amiel-Tison method was scored as 0, a typical result within the normal range; 1, moderate abnormality; 2, high abnormality. At each assessment the infant was classified as

- being normal, if all scores were zero;
- having moderate deficit, if most scores were 1 and some scores were 2; and
- having severe deficit, if the score was 2 in at least 4 or 5 sections.

In the INFANIB method, if the assessment matched the age, a score of 5 was assigned; 3 for 1-stage delay or mild abnormality; and 1 for 2-stage delay or significant abnormality. Based on the total score for that age, at each assessment the infant was classified as abnormal, transient, or normal.

Four clinicians were involved in the neuromotor assessments. Interobserver variability was minimized by comparing 2 independent Amiel-Tison assessments and 5 independent INFANIB assessments in the preparatory phase of the trial. At 12 to 15 months of corrected age, the motor development quotients (MoDQ) and mental development quotients (MeDQ) were assessed by a child psychologist trained in DASII (revised Baroda norms, 1997), blinded to the previous examinations. Statistical analysis was performed using SPSS for Windows, version 16 (SPSS Inc, Chicago, IL, USA). Amiel-Tison and INFANIB neurologic assessment results at 40 weeks corrected age and 3, 6, 9, and 12 months corrected ages were compared with the motor and mental developmental outcomes at 12 to 15 months corrected age. All participants received early

Table 1. Birth Characteristics of the Neonates and Risk Factors of Neurologic Abnormalities

	Number of Participants (*n* = 49)	Percentage
Male:Female	14:35	28.6:71.4
Birth Weight, g		
< 1000	8	16.3
1000–1499	30	61.2
1500–1800	11	22.4
Gestation, wk		
28–30	14	28.5
31–33	26	53.4
> 34	9	18.7
Need for Ventilatory Support		
Noninvasive	7	14
Invasive	17	34.6
Apgar Score < 7 at 5 min	6	12.2
Sepsis		
Suspected	14	28.4
Culture positive	6	12.2
Seizures	1	2
Surgical Interventions	4	8.1
Intraventricular Hemorrhage	1	2
Shock	1	2
Necrotising Enterocolitis	5	10.2

Table 2. Comparison of INFANIB and Amiel-Tison Neuromotor Assessments in Predicing MoDQ Assessed By DASII

Age of Assessment	40 wk Corrected Age		3 mo Corrected Age		6 mo Corrected Age		9 mo Corrected Age		12 mo Corrected Age	
Predictability	INFANIB	Amiel-Tison	INFANIB	Amiel-Tison	INFANIB	Amiel-Tison	INFANIB	Amiel-Tison	INFANIB	Amiel-Tison
Sensitivity, %	66.6	100	100	50	66.6	33.3	100	33	66.6	0
Specificity, %	0	97.8	13.3	97.8	30.3	97.8	45.2	100	75.5	100
PPV, %	4.1	100	4.7	50	4.7	50	13.4	100	14.2	0
NPV, %	100	95.7	100	97.8	94.7	97.8	100	93.8	97.1	93.8

INFANIB, Infant Neurological International Battery; MoDQ, motor developmental quotient; NPV, negative predictive value; PPV, positive predictive value.

intervention therapy by the occupational therapist. A social worker was employed to coordinate and improve follow-ups.

Results

The birth characteristics of the neonates and the risk factors of neurologic abnormalities are depicted in Table 1. Comparison of the 2 methods of assessment in predicting an MoDQ < 70 as assessed by DASII is shown in Table 2. The neurodevelopmental outcome based on DASII, the incidence of hearing deficit, retinopathy of prematurity (ROP), growth at 12 months corrected age is depicted in Table 3. The analysis of the outcome based on gestational age and birth weight is depicted in Tables 4 and 5, respectively.

Table 3. Growth and Developmental Outcomes as per DASII at 12 mo Corrected Age

Outcomes	
DASII at 12 mo (Mean ± SD)	
MoDQ	97.87 ± 21.8
MeDQ	89.64 ± 11.5
DASII < 70, *n* (%)	3 (6)
Abnormal Neuromotor Assessment, *n* (%)	
INFANIB	15 (30.6)
Amiel-Tison	5 (10.2)
Neurosensory Abnormalities	
ROP, *n* (%)	3 (6.1)
Hearing deficit, *n* (%)	2 (4)
Growth	
Weight at 12 mo in kg (Mean ± SD)	7.443 ± 1100
Length at 12 mo in cm (Mean ± SD)	63.89 ± 4.02
Head Circumference at 12 mo in cm (Mean ± SD)	43.4 ± 1.9

DASII, Developmental Assessment Scale for Indian Infants; INFANIB, Infant Neurological International Battery; MeDQ, mental developmental quotient; MoDQ, motor developmental quotient; ROP, retinopathy of prematurity.

Table 4. Gestational Age–Related Neurologic Outcomes of Infants at 12 mo Corrected Age

Gestational Age, wk	DASII		ROP, *n*	Abnormality on Hearing Screen, *n*	Abnormality on INFANIB Assessment, *n*	Abnormality on Amiel–Tison Assessment, *n*
	MoDQ, Mean ± SD	MeDQ, Mean ± SD				
28–30 (*n* = 14)	110.5 ± 33.4	89.9 ± 11.2	1	0	0	0
31–33 (*n* = 36)	92.7± 13.2	88.1 ± 11.6	3	2	11	0
≥ 34 (*n* = 9)	97.3 ± 21.2	92.7 ± 12.8	0	0	4	0

DASII, Developmental Assessment Scale for Indian Infants; INFANIB, Infant Neurological International Battery; MeDQ, mental developmental quotient; MoDQ, motor developmental quotient; ROP, retinopathy of prematurity.

Table 5. Birth Weight–Related Neurologic Outcomes of Infants at 12 mo Corrected Age

Birth Weight, g	DASII		ROP, *n*	Abnormality on Hearing Screen, *n*	Abnormality on INFANIB Assessment, *n*	Abnormality on Amiel–Tison Assessment, *n*
	MoDQ, Mean ± SD	MeDQ, Mean ± SD				
< 1000 (*n* = 8)	101 ± 31	91.8 ± 13.2	0	0	0	0
1000–1500 (*n* = 30)	96.2 ± 23.1	89.2 ± 11.5	3	0	10	0
1500–1800 (*n* = 11)	98.8 ± 15.3	89.2 ± 11.3	0	0	5	0

DASII, Developmental Assessment Scale for Indian Infants; INFANIB, Infant Neurological International Battery; MeDQ, mental developmental quotient; MoDQ, motor developmental quotient; ROP, retinopathy of prematurity.

Discussion

The goal of neonatal intensive care is intact survival of every NICU graduate. Monitoring the developmental outcome of NICU graduates is an integral part of neonatal care. Bayley Scales of Infant Development, a well-accepted scale for assessing the developmental outcome, has been modified as DASII for Indian infants.[8] Although a reliable tool for developmental assessment, DASII is time consuming and requires a trained clinical psychologist for assessment.

Neuromotor assessment in infancy has been found to be a good predictor of developmental outcome.[9] Monitoring neuromotor developments in infancy is challenging because of the rapid and extensive changes.[10,11] Frequent assessments may show markedly different scores due to random variation in performance across assessment sessions rather than the actual change.[12]

Amiel-Tison method of neuromotor assessment has 53 parameters and takes about 10 minutes to assess.[13] INFANIB neuromotor assessment has only 20 parameters and takes about 5 minutes to assess. In this study, we compared the results of these 2 methods of neuromotor assessment, done serially at quarterly intervals, with the outcomes of DASII assessment at 12 to 15 months.

Primary outcome

Comparison of the results of 2 methods of neuromotor assessment

Amiel-Tison method of assessment had a higher sensitivity and specificity at 40 weeks corrected age for identifying neonates with low MoDQ (< 70). However, with advancing age (from 3 to 12 mo), the sensitivity of Amiel-Tison method reduced, though it remained a more specific assessment tool at all ages. INFANIB was more sensitive at 3, 6, 9, and 12 months corrected age. Both these methods had a high negative predictive value (NPV; > 90%), though the positive predictive value (PPV) of Amiel-Tison method was better than that of INFANIB method at all ages. This implies that INFANIB method may be a better tool for screening and Amiel-Tison method may be a better tool for confirmation of the motor abnormality. Further, the high NPV suggests that finding an infant "normal" on neuromotor assessment implies a "normal' developmental quotient. If resources (time and personnel) are scarce, the DASII assessment may be limited to those found abnormal on neuromotor assessment.

The coefficient correlation at different ages between the neuromotor assessment tools and DASII were however poor (INFANIB r = 0.04–0.48; Amiel-Tison r = 0.01–0.22). Head and trunk assessment by the INFANIB method, which includes sitting, pull to sit, all fours, and body derotative had the best correlation at 6 months with DASII (r = 0.48–0.53). INFANIB assessment of vestibular function, which includes backward parachute, forward parachute, sideways parachute, and body rotative, at 6 and 9 months had correlation coefficients of 0.48 and 0.47, respectively.

Soleimani et al[6] found that INFANIB was valid for normal and abnormal groups with 90% sensitivity, 83% specificity, 79% PPV, and 93% NPV. They opine that INFANIB can be an appropriate screening test in developing countries for the reliable measurement of gross motor developmental delay.

Other neuromotor assessment tools such as Test of Infant Motor Performance (TIMP) and Neurosensory Motor Development Assessment have a wide range of sensitivity (43%–81%) and specificity (67%–93%) for predicting abnormal outcome.[14]

Spittle et al[14] in their systematic review of clinimetric properties of neuromotor assessments in preterm infants during the first year of life emphasize that the best predictive assessment tools are age dependent. They found that assessment of general body movements and TIMP were strongest in early infancy (< 4 mo) and Alberta Infant Motor Scale was better in late infancy (8–12 mo). They suggest that selection of motor assessment tools during the first year of life for infants born preterm will depend on the intended purpose such as discrimination, prediction, and/or evaluation.

Secondary outcome

Developmental outcome

In our study, the average MoDQ and MeDQ of all participants were almost normal, with 6 infants having an MoDQ < 90 and 24 infants having an MeDQ < 90. However, only 3 infants had an MoDQ < 70 and

2 infants had an MeDQ < 70. We also found that the MoDQ and MeDQ in the smallest neonates (birth weight < 1000 g and gestation < 30 weeks) were not significantly different from that of the older preterms and infants with birth weight > 1800 g (Tables 4 and 5). This finding was in contrast to other studies where the development was found to be poor with reducing gestational age and birth weight.[15,16] This difference can be attributed to their study cohort not having any extreme premature infants. At 12 months, motor abnormalities were detected in 15 and 5 participants as per Amiel-Tison and INFANIB methods, respectively. The incidence of transient neurologic abnormalities was 69%. The incidence of "abnormal" outcome on INFANIB assessment was only 1 at 40 weeks corrected age and at 12 months. The incidence of "transient" abnormality was observed to reduce from 85% at 40 weeks corrected age to 28% by 1 year. The identification and documentation of these transient neurologic abnormalities, which usually normalize by a year is important as they are known to be associated with learning disabilities at school age.[9,17]

Growth outcome

In our study, the head circumference, known to be a marker of brain growth and development, was just within normal limits. The weight and length of the infants, however, were lower than the third percentile at 12 months of age based on the WHO growth charts. Latal-Hajnal et al[18] found that postnatal growth was poor with anthropometric measurements < 10th percentile at 2 years, and also that poor postnatal growth was associated with poorer neurodevelopmental outcome. The study also states that rapid catch-up growth may at the same time be a risk factor of adult-onset metabolic diseases.

Neurosensory outcome

In our study, only 3 of the 49 infants had ROP and 2 had a minimal hearing deficit, and none of these infants required laser therapy or hearing aid.

Mortality

No mortality was reported during the study.

Neurodevelopmental risk factors in low-birth-weight infants

Of the 49 participants assessed, 8 had a birth weight < 1000 g. They had neonatal morbidities such as perinatal asphyxia (12%), sepsis (40%), and necrotizing enterocolitis (10%), and needed ventilatory support (48%). However, we found that none of these significantly correlated with adverse neurodevelopmental outcomes ($P > .5$).

Limitations

In our study, an abnormal DQ was detected in only 3 participants. Though this is heartening, this could have resulted due to the poor correlation of both Amiel-Tison and INFANIB neuromotor assessment tools with DASII. The study cohort did not include extremely premature infants. Of the 60 enrolled participants, 11 of them did not turn up for follow-ups (despite repeated phone calls). Though home visits were planned initially for managing such cases, it was not feasible.

Conclusions

- INFANIB method is a good neurodevelopmental screening tool at early infancy and Amiel-Tison method is useful for confirming the neurologic abnormality.
- The neurodevelopmental outcome of neonates with birth weight < 1800 g was good with 93% being normal at 1 year of age.
- The incidence of transient abnormalities that normalize by 1 year was high. Hence, documentation of these abnormalities is important.
- Low-birth-weight infants had poor growth with incomplete catch-up growth in terms of weight and length; however, head circumference was appropriate.

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