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Original Article

Relationship Between Neurological Assessments of Preterm Infants in the First 2 Years and Cognitive Outcome at School Age

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ABSTRACT

BACKGROUND: The risk of cognitive disability in preterm infants is higher than in general population. The Amiel-Tison neurological assessment could be a useful tool for early identification of preterm children at risk of cognitive disability in school age. This study investigated the value of categorization of neurological signs assessed by the Amiel-Tison neurological assessment in the first 2 years of life in relation to cognitive performance at school age in a group of preterm children. **METHODS:** Preterm children with gestational age from 23 to 36 weeks were included in the prospective study. From the initial group of 45 children, in whom the Amiel-Tison neurological assessment was performed at term age, at 3 months corrected age, and at 2 years, the Wechsler Intelligence Scale for Children—third edition was performed in 39 children after school entry. **RESULTS:** Full scale IQ, Verbal IQ, and Performance IQ of the whole group of preterm children were not significantly different from the normative data; most of the children had IQ scores in the normal range (≥85). The mean cognitive results of children decreased as the number of neurological signs increased. There was a significant correlation between the categories of neurological signs at 2 years and later cognitive results. **CONCLUSIONS:** The grade of severity of neurological signs at 2 years was associated with the cognitive results at school age. The categorization of neurological signs according to the Amiel-Tison neurological assessment in preterm children might have prognostic value for cognitive outcome at school age.

Keywords: Amiel-Tison neurological assessment, preterm, cognitive, outcome

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Introduction

Medical and technological advances have improved the survival of preterm infants, but neurodevelopmental disabilities remain the most important consequence of preterm birth. Many preterm infants require additional medical and educational resources throughout childhood into adolescence, so it is important to identify these children early. In recent years, the research focus in developmental outcome of preterm infants has shifted from the study of major handicaps, such as intellectual disability, sensorineural hearing loss or blindness, cerebral palsy (CP), and epilepsy, to less severe and more frequent dysfunctions such as learning disabilities, borderline intelligence, neuropsychologic deficits, attention deficit hyperactivity disorder, and other behavioral problems.[1,2] Although new measures of brain structure and function have improved the ability to identify preterm infants at risk of developmental disabilities, neurological assessment remains an important tool in daily clinical practice.

The structural, standardized, and age-dependent Amiel-Tison neurological assessment (ATNA) covers growth parameters and cranial morphology, neurosensory aspects, passive and active muscle tone, spontaneous motor activity, and primary reflexes. It considers signs that depend on the integrity of the upper structures (cranial signs, alertness, and axial tone) and enables a clinician to recognize minor neurological signs from the neonatal period to the age of 6 years.[3,4] Minor neurological signs, which reflect minor brain

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damage occurring before, during, or after birth, present a window into central nervous system disruption, which may present as intellectual, academic, and behavioral problems.[2] Amiel-Tison et al. studied three minor neurological and cranial signs, two of which refer to passive tone (imbalance in axial tone with excessive dorsal extension and a phasic stretch reflex in one or both gastrocnemius muscles), and a palpable ridge on the squamous sutures—the Amiel-Tison triad (ATT). They demonstrated that these signs were important in documenting the relationship between mild brain damage and possible future learning disabilities.[4] Significant correlations between the categories of neurological signs and the Bayley-II Mental Developmental Index have been found at age 2 years.[5,6] At age 2 to 5 years, significant differences in the coordination, language, and practical reasoning according to categories of ATNA were present.[4] Parents of children with abnormal neurological signs on ATNA reported significantly more problems in motor and/or praxis skills, language development, and attention at age 3 to 5 years in comparison with parents of children with optimal neurological status.[7] In the longitudinal study, in which preterm children were classified into three groups (normal, impaired without disability, and with associated disability) at age 1 year, the results of ATNA were predictive of the cognitive performance on Griffiths Developmental Test at age 4, 8, and 14-15 years.[8-10]

The aim of the study was to evaluate the usefulness of ATNA for predicting developmental disabilities and to analyze the correlation between neurological signs assessed at three periods (newborn, infant, and toddler age) and cognitive performance at school age in a heterogeneous group of preterm children. The study is a part of a longitudinal follow-up of preterm children in which ATNA proved to be a useful clinical tool for predicting cognitive outcome at 2 years.[5]

Materials and Methods

Participants

In a single-centre longitudinal cohort study, we monitored a group of 45 preterm infants (23 boys and 22 girls) born in the period 2001-2004. All except three children were born at the Ljubljana Maternity Hospital. The inclusion criteria were (1) gestational age of 36 weeks or less; (2) one or more neonatal complications; and (3) first neurological examination at the corrected age of 40 weeks (±5 days). Children with dysmorphic syndromes and chromosomal abnormalities were excluded from the study.

Measures

Neurological status was assessed using ATNA. The assessment of neurological status is age dependent, with different items being assessed at different ages. The interpretation of findings relies on the pattern of maturation of the subcorticospinal and corticospinal motor control systems.[3] The scoring is based on a three-point scale, where 0 indicates a typical result for that age, 1 indicates a moderately abnormal result for that age, and 2 indicates a definitely abnormal result. The final synthesis of the neurological status relies on clusters of neurological signs that produce a categorization of the severity of neurological signs. The categorization varies at different ages: at term age, there are three categories of neurological signs for preterm infants (normal, minor to moderate, and severe degrees of neurological signs); at 3 months, there are four categories (normal, minor, moderate, and severe degrees of neurological signs); and at 2 years, there are six categories (normal, intermediate with one ATT sign, intermediate with two ATT signs, ATT, minimal CP, and CP). The detailed procedures, scoring, and categorization of neurological signs are described elsewhere.[3,11,12]

Cognitive abilities at school age were assessed using the Wechsler Intelligence Scale for Children—third edition.[13] Three composite scores were calculated: Full Scale IQ (FIQ), Verbal IQ (VIQ), and Performance IQ (PIQ). The results of IQ scores were considered as severely abnormal when the S.D. values were below −2, as mildly abnormal when between −1 and −2, and normal when −1 below the mean or higher.

After the cognitive assessment at school age, parents were asked if their child was recognized as having special education needs according to the Slovenian Special Education Act.

Procedure

After discharge from the maternity hospital, children were routinely referred to their regional outpatient Developmental Centre. Infants whose parents agreed to participate and signed an informed consent form were consequently enrolled in the study. ATNA was performed by an experienced pediatrician at term age and repeated every 3 months up to the age of 2 years when the final categorization was made. When children started school, they were invited for cognitive assessment; if there was no response, another postal and then telephone contact were attempted; and if there was still no response, a final invitation letter was sent a few months later. An experienced psychologist performed the cognitive assessment individually.

The National Medical Ethics Committee in Slovenia approved the study.

Statistical analysis

The mean and the S.D. of FIQ, VIQ, and PIQ were used in analysis. The measures of skewness and kurtosis were calculated for the distribution of the IQ scores. The z scores for skewness and kurtosis were 0.30 and −0.51, respectively, for the FIQ; 0.55 and 0.32, respectively, for the VIQ; and 0.21 and −0.53, respectively, for the PIQ. Both measures were below the limit of z score of ±2.58, the level at which the distribution is considered to be significantly skewed or kurtic.[14] A one-group t test was used to compare the results of the studied group with the reference population. P values <0.05 were considered significant. The effect size was computed using Cohen d, where a d of 0.2 represents a small, d of 0.5 a medium, and d of 0.8 a large effect size.[14] Spearman's rho (ρ) correlation coefficient was used to assess the relationships between categories of children according to neurological signs with cognitive outcome (FIQ, NIQ, and PIQ). Statistical analysis was performed using the IBM SPSS Statistics, version 20. Categorization of neurological status as normal and abnormal was used for the computation of sensitivity, specificity, and positive predictive value and negative predictive value. This was performed using MedCalc for Windows, version 12.5 (MedCalc Software, Ostend, Belgium).

Results

Participants

Initially, 45 infants were included in the study. They were born with a gestational age from 23 to 36 weeks (mean gestational age, 31.6 weeks; S.D., 3.3 weeks) and birth weight from 525 to 3240 g (mean, 1788 g; S.D., 718 g). Seven infants had extremely low birth weights, 17 infants had birth weights below 1500 g. Six infants were small for gestational age, two were large for gestational age, and the others were appropriate for gestational age. There were eight pairs of twins. Twenty-six children experienced one additional neonatal complication besides prematurity, whereas 19 experienced two or more. The perinatal and neonatal characteristics of the participants are presented in Table 1. Neurological assessments using ATNA were