Short-latency Somatosensory Evoked Potentials in Perinatal Asphyxia

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Ten asphyxiated term newborns were studied in the first 6 months of life with median nerve short-latency somatosensory evoked potentials (SLSEP) and followed subsequently to a mean age of 20 months. Results of SLSEP correlated with subsequent outcome in every patient; normal and abnormal infants at subsequent examination were separable on the basis of prior SLSEP, although the severity of later disability could not be inferred from SLSEP.

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Introduction

Numerous investigators have suggested methods for predicting the neurodevelopmental future of the term newborn surviving an episode of asphyxia. Clinical evaluation [1-9], cranial ultrasound examination [10], radionuclide brain scan [11], cranial computed tomography [5,12,13], measurement of cerebral blood flow [14,15], electroencephalography (EEG) [16-18], and brainstem auditory evoked potentials [19-21] have been applied to this prognostic challenge. All of these techniques have demonstrated significant predictive errors. One earlier study of somatosensory evoked potentials (SEPs) in combination with visual evoked potentials suggested promise for SEP as a prognostic technique, but this work had major methodologic and technical flaws; techniques and normative data for SEP were poorly defined and the involved infants were not evaluated beyond the first few months of life [22]. As part of a study of evoked potentials in high-risk newborns, we performed short-latency SEPs (SLSEPs) at 2-6 months of age on 10 term infants with perinatal asphyxia, using techniques and normative data established previously [23]. These infants then received neurologic and developmental evaluations at an average age of 20 months in order to establish utility for SLSEPs in predicting their neurodevelopmental outcomes. Results of SLSEPs were predictive of the findings on subsequent evaluations.

Methods

After informed parental consent had been obtained, term newborns (> 37 weeks gestational age) were recruited. Criteria for inclusion in the study were as follows:

(1) Asphyxia as a primary clinical diagnosis;

(2) Absence of congenital anomalies, infections, or metabolic disease; and,

(3) Presence of any two of the following: neonatal seizures, need for mechanical ventilation, 5 minute Apgar score < 4, and burst-suppression (periodic) pattern on EEG.

Recruited infants then were scheduled for SLSEP at 2, 4, and 6 months of age (corrected for gestational age).

SLSEP studies were performed and evaluated as described in a previous study of normal infants [23]. A 0.2 msec rectangular electrical pulse was delivered at a rate of 5.1/sec by placing the cathode on the ventral wrist overlying the median nerve and the anode on the dorsum of the wrist. Stimulus intensity was that required to produce a minimal thumb twitch (5-15 mA). The left and right wrists were stimulated separately. Bandpass was 30-3,000 Hz (-3 dB). The 60 Hz notch filter was not used. Sweep time was 100 msec. One thousand trials were averaged. Each average was replicated. Three channels were recorded: C_4' or C_3' - Fz, C II-Fz, and Erb's point-Fz. All electrodes were attached with collodion in gauze mesh. A ground electrode was placed on the forehead.

Recruited infants who had received at least one SLSEP were scheduled for subsequent examinations after 18 months of age. This evaluation included:

(1) Neurologic examination by a pediatric neurologist (C.D.) uninformed of SLSEP results, with particular notation of head circumference, motor abnormalities, and a quantitative assessment of motor disability (none; mild = abnormal posture; moderate = locomotion impaired; severe = locomotion impossible); and,

(2) Administration of the Bayley Scales of Infant Development by a qualified psychologist (R.B.) blind to SLSEP results. The 10 infants reported here had subsequent evaluations at > 19 months of age, except one (Table 1: Patient 9) who died of sepsis at 5 months of age; when examined for SLSEP at 4 months of age, this child was spastic in all limbs, microcephalic, severely retarded, and suffered from infantile spasms.

SLSEP results were compared to prior norms for abnormalities of latency and amplitude of the early cerebral components N_1/P_1 [23]. SLSEPs were considered abnormal when an N_1/P_1 was absent or had a latency > 3 standard deviations above the mean.

Results

Results are summarized in Table 1. Excellent correlation is demonstrated between SLSEP and later neurologic examination. No child with 2 or more normal SLSEP studies (Patients 1-4) had subsequent disability or abnormal motor findings on neurologic examination. No child with moderate-severe disability

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Table 1. Perinatal, SLSEP, and follow-up data in asphyxiated term neonates

Patient Number	Basis for Asphyxia	Birth Weight (Grams)	EGA (Weeks)	Age at Follow-up (Months)	SLSEP at 2 Months / 4 Months / 6 Months	OFC (%tile) Birth / Follow-up	Bayley Motor / Mental Quotient	Follow-up Motor Abnormalities	Disability
1	Perinatal depression	3550	40	21	WNL/WNL/WNL	50/75	104/83	None	None
2	Prolapsed umbilical cord	2360	40	20	WNL/WNL/WNL	25/25	60/86	None	None
3	Intrapartum asphyxia	2860	40	22	WNL/WNL/WNL	50/25	101/113	None	None
4	Meconium aspiration	3270	40	27	WNL/WNL/WNL	25/2	83/81	None	None
5	Respiratory arrest	3200	40	19	B late N1, B late P1/NP/NP	50/25	56/100	B choreo-athetosis	Mild
6	Intrapartum asphyxia	3320	41	19	B absent/WNL/WNL	10/25	70/91	B choreo-athetosis	Mild
7	Meconium aspiration	3380	40	26	B absent/NP/ B absent	75/<2	<50/<50	Spastic quadriparesis	Severe

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Table 1. Perinatal, SLSEP, and follow-up data in asphyxiated term neonates (continued)

Patient Number	Basis for Asphyxia	Birth Weight (Grams)	EGA (Weeks)	Age at Follow-up (Months)	SLSEP at 2 Months / 4 Months / 6 Months	OFC (%tile) Birth / Follow-up	Bayley Motor / Mental Quotient	Follow-up Motor Abnormalities	Disability
8	Meconium aspiration	3470	40	21	B absent / B absent / L late N1, L late P1	50 / < 2	< 50 / < 50	Spastic quadriparesis right worse	Severe
9	Uterine rupture	4120	41	Died at 5 months	NP / B absent / NP	50 / < 2*	NP	Spastic quadriparesis; no development at 4 months	Severe
10	Intrapartum asphyxia	2330	37	20	R absent / R absent WNL	10 / < 2	50 / < 50	B hypotonic	Moderate

* = Occipitofrontal circumference at 4 months of age

Abbreviations:
B = Bilateral
EGA = Estimated gestational age
L = Left
NP = Not performed
OFC = Occipitofrontal circumference
R = Right
WNL = Normal

(Patients 7-10) had 2 normal SLSEP studies. No child escaped neurologic abnormality who had a single SLSEP study with unilateral or bilateral absence of cerebral response (Patients 6-10) or who had abnormal latencies of early waves N_1/P_1 (Patients 5,8). Fisher exact test yields a two-tailed p value of 0.005, disclosing a significant increase in the risk of neurologic abnormality at subsequent examination for those with abnormal SLSEPs. Measurements of head circumference served to distinguish the microcephalic moderate-severe group in whom postnatal head growth was markedly impaired. Head growth, however, was relatively diminished in one normal child (Patient 4) and was unimpaired in both mildly disabled children (Patients 5,6) who had choreoathetosis with expectedly better mental than motor scores; their motor scores were in the intermediate range, falling between the normal and moderate-severe groups.

Discussion

SLSEPs are easily performed on young infants and adequate norms exist for this age group [23]. Because the cerebral response is not well-developed until 2 months of age, SLSEPs are performed after the neonatal period, obviating any need to study an acutely ill newborn for prognostic purposes. In our asphyxiated term infants, SLSEPs distinguished subsequently normal from abnormal infants on neurologic examination. Using SLSEPs, a distinction between mildly and moderately-severely affected infants could not be made on the basis of this preliminary study.

A recent study of a large heterogenous group of high-risk infants demonstrated that abnormalities of the early N_1 component of SLSEP in infants always were correlated with later handicap; however, term infants with perinatal asphyxia were not addressed specifically in this report [24].

To our knowledge, only one prior study of SEPs in perinatal asphyxia has been reported and it suggested a correlation between degree of asphyxia, SEPs, and short-term outcome [22]. Limited subsequent examinations of studied infants, however, compromised these data. In addition, normative data on SEP technique were not given and certain critical, technical issues (i.e., bandpass, scoring of early versus late peaks) were ignored.

Our data suggest that SLSEPs in term asphyxiated neonates have substantial prognostic accuracy. Moreover, SLSEPs need not be performed in the acute perinatal period. Only further study of a larger group of infants can confirm this apparent prognostic accuracy of SLSEP. Until such work is completed, we suggest that SLSEP be performed at least twice in such infants to minimize predictive errors. In addition, infants should have SLSEP studies performed in the waking state to avoid the distortion of SLSEPs during stage II in infants [25].

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