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Clinical Section

SPECTRAL ANALYSIS OF INFANT EEG AND BEHAVIORAL OUTCOME AT AGE FIVE [1,2]

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Summary Power spectral and discriminant analysis techniques were used to compare EEG records obtained at term and at 3 months past term from 5 groups of varying risk and developmental outcome. The groups were: (1) healthy full-terms; (2) healthy pre-terms with normal outcomes; (3) sick pre-terms with normal outcomes; (4) sick pre-terms with delayed development; (5) sick pre-terms with later neurological problems. The EEG samples recorded at term were identified as belonging to the correct subject group at 52–70% accurracy, 20% being chance for 5 groups. The accuracy varied with the 4 classes of EEG patterns used. The individual subjects were also classified into their correct groups with few exceptions. Similar success was obtained with EEG samples selected from recording at 3 months past term.

The predominant power spectral discriminating features were changes in intra- and inter-hemispheric coherence, and increased power, particularly in the middle and higher frequency range. Thus, computer analyses of EEG samples, using features not readily identified visually, differentiated risk from non-risk infants and also differentiated infants with substantial neonatal medical complications who have good or poor developmental outcomes.

Keywords: *EEG – high-risk infants – preterm infants – power spectral analysis*

Infants who have suffered perinatal problems are at greater risk for later developmental and behavior difficulties than those who have not. Infants born pre term are a prototype of such infants since they frequently have major perinatal problems in addition to being physiologically immature at birth. Follow-up studies of pre-term infants have clearly demonstrated that as a group they have more mental retardation, neurological, and school learning problems (Drillen et al. 1980; Hunt et al. 1982). Nevertheless, it has been difficult to predict which pre-term infants will have later difficulties on the basis of birth weight, gestational age, obstetric and neonatal complications, and combinations of these factors (Cohen and Parmelee 1983). Being born small and sick influences deviant outcome, nevertheless the majority of such infants do well. The task is to identify those infants who will have later problems.

As part of a prospective longitudinal study of pre-term infants, measures of sleep state organization and EEG patterns were included along with behavioral and social variables in order to improve the identification of later developmental problems (Parmelee et al. 1976). We considered that sleep state organization with associated EEG patterns might provide an index of the maturity and integrity of neurophysiological organization. EEG activity and sleep state organization show developmental trends, particularly in early infancy (Stern et al. 1969; Parmelee and Stern 1972). There are also identifiable differences in sleep state organization and in EEG activity between healthy full-term infants and infants with neonatal neurological problems, and between healthy infants and those with obstetric or neonatal medical complications such as maternal toxemia, drug addiction, pre-term birth, neonatal hypoxia, and hyperbilirubinemia (Schulte et al. 1972; Prechtl 1974; Theorell et al.

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1974; Havlicek et al. 1975, 1977; Haas and Prechtl 1977; Booth et al. 1980; Lombroso 1982). However, efforts to predict later deviant or delayed development in infants considered at risk but without overt neurological signs have, in general, not been very successful. Yet, there is scattered evidence that some aspects of sleep state organization and associated EEG patterns are related to later functioning (Tharp et al. 1981; Thoman et al. 1981; Crowell et al. 1982).

A potentially useful method of EEG analysis is power spectral analysis. These analyses, however, require a large amount of computer time both for the digitizing process and the ultimate power spectral analyses. We decided to do a retrospective analysis of the relationship between power spectral characteristics of infant EEG and neurological and intellectual status at 5 years of age. We chose to include sick pre-terms, well pre-terms, and well full-term infants in the study. Since there are currently many studies of neonatal EEG in progress and our retrospective study indicates a relation between infant EEG patterns and 5 year outcome using power spectral and discriminant analysis techniques, we feel it is useful to present our results using this analysis technique.

Method

Subjects

The subjects were obtained from a prospective, longitudinal study of 126 pre-term and full-term infants, treated in the UCLA nursery in the years 1972–74. These infants were studied intensively from birth to 2 years, and then retested at age 5. Pre-term subjects were included in the prospective study who were born at 37 weeks gestation or less, and 2500 g or less, without obvious congenital anomalies. The physiological condition of the infants at birth was greatly variable. The prospective study sample represented a broad range of social class and ethnic background. For the purpose of this study, only children with English-speaking parents were chosen in order to simplify cultural influences on the outcome measure.

There were 83 infants of English-speaking families of whom 45 children were chosen for this study. The subjects were selected in order to compare full-term, well pre-terms, and sick pre-terms with and without later intellectual and neurological problems.

Five groups were derived according to gestational age, risk status, and intellectual and neuro-

TABLE I

Subject characteristics.

	N	Gestational age	Obstetrics and postnatal complications	5 year Stanford-Binet IQ
1. Full-term good outcome low risk	10	40.2 (38–42)	246.3 * (184–291)	116.2 (102–151)
2. Pre-term low risk good outcome	9	33.1 (26–36)	206.4 (179–272)	114.3 (100–127)
3. Pre-term high risk good outcome	9	31.2 (26–35)	151.6 (134–173)	117.8 (107–134)
4. Pre-term high risk poor outcome	8	31.5 (26–35)	148.9 (135–174)	87 (73–94)
5. Neurological abnormality	8 **	33.4 (27–36)	141.2 (105–179)	69.2 ** (41–84)

* A high score is a good score with a perfect score of 400 and an average score of 200 and a standard deviation of ±40.

** Three children were seen at 5 years but were not given the Stanford-Binet because of the severity of their handicaps.

logical outcome. Table I gives a full description of the 5 groups. Gestational age was determined by the mother's report of the last menstrual cycle. The risk status evaluation used combined scores from the Obstetrics Complications Scale and the Postnatal Complications Scale (Littman and Parmelee 1978), which notes hazardous medical events in the prenatal and perinatal periods, respectively. The Stanford-Binet test form L-M was administered at age 5 to determine intellectual outcome. There were no significant differences among the 4 pre-term groups on gestational age, birthweight, or socioeconomic status.

Sleep recording

Sleep polygraph recordings were made in a sound-attenuated room in the morning at term (40 weeks conceptional age) and 3 months past term (53 weeks conceptional age). Eye movements, respiration, heart rate and 8 channels of EEG were recorded continuously on paper and magnetic tape. Body movements and eye movements were noted by observers and recorded by event markers on the paper and the tape. A time code was recorded on the paper and tape at 20 sec intervals so that specific segments of the tape could be readily located for computer analyses. Each recording lasted 90 min and only the last 60 min were used for analysis. Thus, each infant had the same 30 min period for settling-in and sleep induction and the same length of record for analysis.

Behavioral state was determined by visually analyzing each 20 sec epoch. State was determined independently of EEG patterns by the following criteria: *awake* — eyes open; *asleep* — eyes closed; *quiet sleep (NREM)* — eyes closed, no eye movements, no body movements except for occasional body jerks, and regular aspiration; *active sleep (REM)* — eyes closed, eye movements, body movements, and irregular respiration; *transitional sleep* — eyes closed but incomplete criteria for either of the sleep states.

The EEG scalp electrodes were placed according to the 10-20 system with four on each side of the head. The recordings were bipolar as follows: Fp1-T3, Fp1-C3, T3-O1, C3-O1, and Fp2-T4, Fp2-C4, T4-O2, C4-O2. The analysis of EEG patterns was done for each 20 sec epoch using a numbered coding system. The coding system is detailed in Table II, and Fig. 1 illustrates the types of EEG patterns for each code found at the 2 recording ages. The most common EEG patients in active (REM) sleep in term infants are 402 (LVI) and 403 (M), and the most common patterns in quiet (NREM) sleep are 407 (TA) and 405 (HVS) (Parmelee et al. 1969; Anders et al. 1971). The most common EEG patterns in active (REM) sleep in 3-month-old infants are 533 (TSL) and 535 (IS), and the most common patterns in quiet (NREM) sleep are 538 (HVSp) and 536 (LVSp) (Parmelee et al. 1968).

TABLE II

EEG patterns at term and at 3 months past term.

Term patterns

402 — Low voltage irregular (LVI). Irregular continuous activity with periods of 3–8 sec duration of very rhythmical 4–8 Hz activity of 20–50 μV.

403 — Mixed (M). Polymorphic, diffuse, 0.5–13 Hz waves of 30–100 μV, maximal over the frontal areas with occasional periods of rhythmic activity of 4–8 Hz.

405 — High voltage slow (HVS). Activity of 2.0–4.0 Hz waves of 50–150 μV and 4–8 Hz waves of 50 μV. In the frontal area the 2.0–4.0 Hz activity may occur as groups of sharp waves.

407 — Tracé alternant (TA). Bursts of large amplitude slow (0.5–3.0 Hz) waves, occasionally superimposed by rapid low voltage waves and sharp waves of 2–4 sec duration, separated by 4–8 sec of attenuated activity of mixed frequencies.

Three month patterns

533 — Theta and slow low voltage (TSL). Background activity of 3–5 Hz waves of 40–80 μV, occasionally in groups with amplitudes over 100 μV in the occipital area.

535 — Irregular slow (IS). Irregular slow waves of 1–5 Hz waves of 100–200 μV that are more pronounced in the occipital area. The 3–5 Hz waves are more evenly distributed and of smaller amplitude.

536 — Low voltage with spindles (LVSp). Slow activity of 2–5 Hz waves of less than 100 μV; occasional larger amplitude sharp waves and scattered 14 Hz spindles of less than 45 μV.

538 — High voltage with spindles (HVSp). Polymorphic activity of 1–2 Hz waves are more pronounced in the occipital area and the 3–5 Hz waves evenly distributed. Sleep spindles are frequent and often superimposed on the large slow waves.

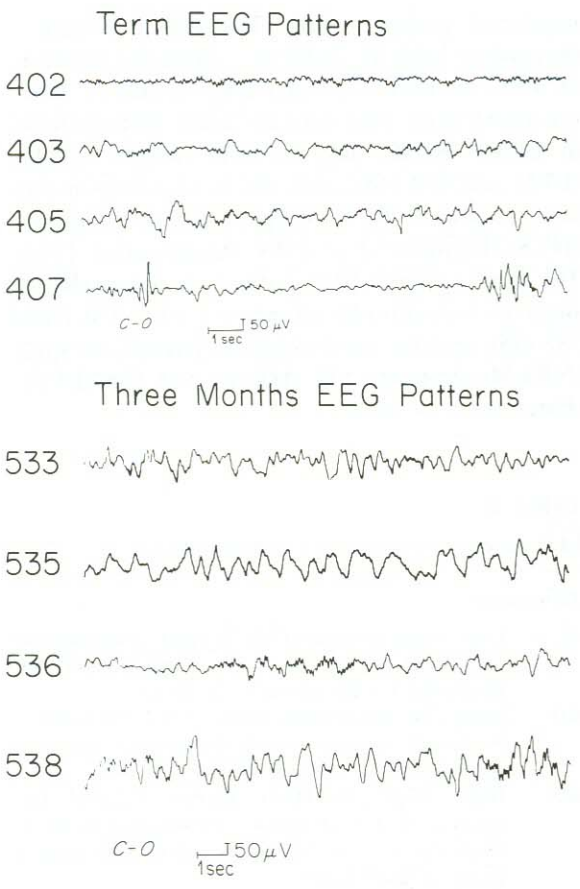

Fig. 1. Examples of each of the EEG patterns at term and 3 months.

Multiple 20 sec epochs were selected from each subject's recordings. The recordings were selected by taking the first three 20 sec epochs of each of the 4 EEG patterns in each of the 3 states (quiet, active, and transitional) as they occurred. If a child showed all EEG patterns in each sleep state, 36 samples were possible. However, not all EEG patterns were shown in each sleep state by each child. The distribution of EEG patterns and sleep states did not differ significantly across groups. There were between 121 and 402 samples of each of the 4 patterns at each age tested, with an average of 265 samples per pattern at term and 176 samples per pattern at 3 months.

The EEG from the chosen epochs was digitized at 100 Hz with a PDP-11 laboratory computer. The EEG data used for computer analyses were from 3 bipolar leads from each hemisphere, Fp1-T3, C3-O1, T3-O1, and Fp2-T4, C4-O2, T4-O2. Spectral analysis methods were used to quantify 135 descriptors, including spectral power, coherence between leads, and variance of power, from 5 frequency bands: 0.1–3.5 Hz (delta), 4–7.5 Hz (theta), 8–12.5 Hz (alpha), 13–25 Hz (beta), and 11–16 Hz (sigma). The sigma band contains primarily sleep spindles and overlaps the alpha and beta frequency bands.

Results

The first question to be addressed was whether individual EEG epochs could be identified as belonging to the group of the subject from whom the recording was made. Stepwise discriminant analysis was used to compute discriminant functions with the spectral analysis measures as discriminating variables, and the 5 subject categories (Table I) as the groups. These functions were done separately for the 4 EEG patterns of each testing age. The discriminant functions were computed on a randomly selected half of the data (training sample). Based on the discriminant function from the training sample, the epochs from the remaining half of the data (replication sample) were assigned to the 5 risk-outcome subject groups based on the highest probability of group membership.

The results for the replication sample at the term recording age are presented in Tables III and IV. The percentage of correct assignment of epochs as belonging to infants from 1 of the 5 groups ranged from 52 to 70% at 40 weeks conceptional age (Table IV). Since each epoch by chance could be assigned into any 1 of 5 groups, the assignment by spectral analysis was more successful than the expected chance rate of 20%. When the groups were combined as to presence (groups 4 and 5) or absence (groups 1, 2, 3) of developmental or neurological problems at age 5, a 70–79% correct classification was made (Table IV). Additionally, when infants of group 3, pre-term infants with many perinatal complications without developmental problems, were compared to infants of group 4, pre-term infants with many perinatal complications with developmental problems, EEG

TABLE III

Power spectral and discriminant analysis distribution of term EEG patterns by subject groups.

Actual subject group	Number of EEG epochs	Predicted subject group				
		1	2	3	4	5
(A) EEG pattern 402, LVI, low voltage irregular						
1	37	26	7	2	1	1
	100%	**70.3**	18.9	5.4	2.7	2.7
2	28	3	22	1	1	1
	100%	10.7	**78.6**	3.6	3.6	3.6
3	27	1	2	24	0	0
	100%	3.7	7.4	**88.9**	0	0
4	16	1	1	1	13	0
	100%	6.3	6.3	6.3	**81.3**	0
5	30	0	0	0	0	30
	100%	0	0	0	0	**100**
(B) EEG pattern 403, M, mixed						
1	39	30	4	0	4	1
	100%	**76.9**	10.3	0	10.3	2.6
2	35	1	**31**	1	2	1
	100%	2.9	89.7	2.6	5.1	2.6
3	33	2	0	**24**	5	2
	100%	6.1	0	68.6	14.3	5.7
4	33	0	3	4	**26**	1
	100%	0	8.6	12.1	**78.8**	3.0
5	30	0	0	1	1	**29**
	100%	0	0	3.0	3.0	**87.9**
(C) EEG pattern 405, HVS, high voltage slow						
1	21	**20**	0	1	0	0
	100%	**95.2**	0	4.8	0	0
2	10	0	**10**	0	0	0
	100%	0	**100.0**	0	0	0
3	19	0	0	**17**	2	0
	100%	0	0	**89.5**	10.5	0
4	19	0	1	1	**17**	0
	100%	0	5.3	5.3	**89.5**	0
5	13	0	0	0	0	**13**
	100%	0	0	0	0	**100.0**
(D) EEG pattern 407, TA, tracé alternant						
1	37	**32**	1	2	2	0
	100%	**86.5**	2.7	5.4	5.4	0
2	28	0	**25**	3	0	0
	100%	0	**89.3**	10.7	0	0
3	22	0	2	**18**	2	0
	100%	0	9.1	**81.8**	9.1	0
4	24	1	4	1	**18**	0
	100%	4.2	16.7	4.2	**75.0**	0
5	21	0	1	0	1	**19**
	100%	0	4.8	0	4.8	**90.5**

These predicted distributions were done on half of the total sample of each EEG pattern, the criteria having been established first on the other half of the sample randomly chosen.

patterns were correctly classified with 73–83% accuracy (Table IV).

Similar analyses were done for the 3 month EEG patterns. Table V contains the results of the replication sample for each of the 3 month EEG patterns separately by the 5 groups. The patterns were correctly assigned to infants in 1 of the 5 groups at 32–58% accuracy (Table VI). These patterns were also successfully assigned as belonging to infants in the good outcome groups (groups 1, 2 and 3) or poor outcome groups (groups 4 and 5) with 64–75% success. Patterns were assigned as coming from infants of group 3 (high-risk, normal IQ outcome) or group 4 (high-risk, poor IQ outcome) with 59–94% success (Table VI). The EEG patterns 536 (LVSp) and 538 (HVSp), each with sleep spindles, were particularly successful in the latter analysis, being assigned correctly 94 and 83% of the time, respectively (Table VI).

The second question to be addressed was if individual infants (rather than epochs) could be correctly assigned to the 5 risk-outcome groups based on the discriminant function analysis. The assignment of the 20 sec epochs to the 5 groups was aggregated for each infant. Infants were assigned to 1 of the 5 risk-outcome groups based on the modal group assignment of the aggregated 20 sec epochs recorded from the subject. Table VII presents the results of this analysis. The analysis of the term sleep recording resulted in 38 of the 44 infants being correctly assigned to their subject group. At 53 weeks, 37 of the 44 infants were correctly assigned to their subject group.

In order to determine what aspects of the EEG patterns contributed the most to the classifications, we examined those variables that entered first into the discriminating functions. We know from previous studies that when power spectral and discriminant analyses are used to differentiate the patterns at term and 3 months, the same features that are visually used are most useful in the quantitative analysis. However, we wish to know if the power spectral characteristics are the same as the visual characteristics when coming from infant groups with varying neonatal risk and developmental outcome. Power in the beta frequency band and the intra- and inter-hemispheric coherence in this frequency band were the primary discriminators of group membership for all of the term EEG patterns. Coherence in the theta and alpha frequencies was chosen as a discriminator with slightly less frequency than the beta frequency band variables. Using epochs from the 3 month EEG pattern 533 (TSL), the subject groups are primarily discriminated by the power and coherence within and across hemispheres in the delta and theta frequency bands. The groups were discriminated with the 535 (IS) pattern epochs by power in the theta frequency band, and coherence within and across hemispheres in the theta and delta frequency bands. Epochs from the two EEG patterns with sleep spindles, 536 (LVSp) and 538 (HVSp), discriminated the 5 groups with power and coherence within and across hemispheres in the sigma, theta, and delta frequency bands.

It is interesting that power in frequency bands not usually used in visual discrimination of the different EEG patterns was used in the discriminant analysis to separate the subject groups. The only major exception to this was the sigma spindle frequency band at 3 months of age. Similarly, coherence in several frequency bands within hemispheres from forward to posterior electrodes, and

TABLE IV

Classification of term EEG patterns of outcome groups (%).

EEG code	Description	All 5 groups	Good outcome groups 1, 2, 3 vs. poor outcome groups 4, 5	Pre-term sick good outcome group 3 vs. pre-term sick poor outcome group 4
402	High freq., low power	70	74	83
403	Mixed freq., mod. power	52	74	73
405	Low freq., high power	47	70	77
407	Tracé alternant, power burst-suppression	53	79	75

TABLE V

Power spectral and discriminant analysis distribution of 3 month EEG patterns by subject groups.

Actual subject group	Number of EEG epochs	Predicted subject group				
		1	2	3	4	5
(A) EEG pattern 533, TSL, theta and slow low voltage						
1	61	42	8	1	7	3
	100%	**68.9**	13.1	1.6	11.5	4.9
2	36	3	27	2	1	3
	100%	8.3	**75.0**	5.6	2.8	8.3
3	36	1	3	26	3	3
	100%	2.8	8.3	**72.2**	8.3	8.3
4	39	7	6	2	24	0
	100%	17.9	15.4	5.1	**61.5**	0
5	29	0	2	2	0	25
	100%	0	6.9	6.9	0	**86.2**
(B) EEG pattern 535, IS, irregular slow						
1	19	19	0	0	0	0
	100%	**100**	0	0	0	0
2	18	2	16	0	0	0
	100%	11.1	**88.9**	0	0	0
3	9	0	0	9	0	0
	100%	0	0	**100.0**	0	0
4	15	1	0	0	13	1
	100%	6.7	0	0	**86.7**	6.7
5	14	0	0	0	1	13
	100%	0	0	0	7.1	**92.9**
(C) EEG pattern 536, LVSp, low voltage with spindles						
1	13	12	0	0	0	1
	100%	**92.3**	0	0	0	7.7
2	16	1	15	0	0	0
	100%	6.3	**93.8**	0	0	0
3	8	0	0	8	0	0
	100%	0	0	**100.0**	0	0
4	21	0	0	0	21	0
	100%	0	0	0	**100.0**	0
5	8	0	0	0	0	8
	100%	0	0	0	0	**100.0**
(D) EEG pattern 538, HVSp, high voltage with spindles						
1	25	19	1	1	2	2
	100%	**76.0**	4.0	4.0	8.0	8.0
2	30	1	25	1	0	3
	100%	3.3	**83.3**	3.3	0	10.0
3	25	2	2	21	0	0
	100%	8.0	8.0	**84.0**	0	0
4	23	1	0	1	19	2
	100%	4.3	0	4.3	**82.6**	8.7
5	18	0	1	0	0	17
	100%	0	5.6	0	0	**94.4**

These predicted distributions were done on half of the total sample of each EEG pattern, the criteria having been established first on the other half of the sample randomly chosen.

TABLE VI

Classification of 3 month EEG patterns by outcome groups (%).

EEG code	Description	All 5 groups	Good outcome groups 1, 2, 3 vs. poor outcome groups 4, 5	Pre-term sick good outcome group 3 vs. pre-term sick poor outcome group 4
533	Mixed freq., mod. power	50	64	69
535	Low freq., high power	32	70	59
536	Low freq., high power, sleep spindles	58	74	94
538	Low freq., high power, sleep spindles	54	75	83

TABLE VII

Classification of subjects by groups based on the model EEG pattern classification for each subject.

Actual subject group	Predicted subject group					N
	1	2	3	4	5	
(A) By term EEG patterns						
1	9	1				10
2		9				9
3			9			9
4		1	1	6		8
5		2		1	5	8
						44
(B) By 3 month EEG patterns						
1	9				1	10
2		8		1		9
3		2	7			9
4	1		1	6		8
5				1	7	8
						44

at similar electrode placements between hemispheres, were major discriminators. Coherence or shared power cannot be readily identified visually. The discriminant analysis of power spectral data, therefore, adds considerably to visual analyses, since parameters are used that are generally not evident visually.

Discussion

This retrospective study demonstrates that infant EEG may be useful in diagnosing neurological and behavioral outcomes in infants with varying degrees of neonatal risk. The computer analysis of tape-recorded EEG effectively made use of power spectral characteristics not easily recognizable with visual analysis. These characteristics, recorded at term and at 3 months of age, were useful in correctly classifying infants' behavioral outcomes at 5 years of age.

The probability of classifying individual subjects into groups can be overestimated using discriminant analysis with a large number of discriminating variables. Stepwise discriminant analysis compounds this difficulty since a different set of variables is likely to be chosen for each new set of data, making the results unique to the specific

data set. To overcome this, the discriminant functions relating the spectral analysis characteristics to the groups were established on a randomly chosen half of the EEG samples, and then tested on the remaining half. It is the successful classification of the replication sample that we have reported. The findings were further validated by the correct classification of the subjects into their appropriate groups by the modal classification of each of their EEG patterns.

In several power spectral analyses of neonatal EEGs, risk groups have been different than controls in power and coherence variables similar to those selected by our discriminant analysis procedures. These include shifts of power in the high frequency bands and changes in location and magnitude in intra- and inter-hemispheric coherences. The risk groups that have been studied include newborn infants of alcoholic mothers (Havlicek et al. 1975), small for gestational age infants of toxemic mothers (Schulte et al. 1972), sick full-term (Prechtl and Vos 1973; Duffy and Als 1983) and pre-term infants (Havlicek et al. 1977).

Most of the studies of infants 3 months past term have focused on sleep spindles in quiet sleep as criteria of brain maturation (Schulte and Bell 1973). We found an absence of sleep spindles in infants with untreated hypothyroidism (Schulz et al. 1968) and reported on an infant who suffered neonatal hypoxia and later developed cerebral palsy who had no sleep spindles at 3 months (Parmelee et al. 1968). Older retarded children show an absence or poor development of sleep spindles (Shibagaki et al. 1982). Sleep spindle development at 3 months of age is delayed in infants who have had neonatal problems (Wu et al. 1980). Sleep stages of quiet sleep at 3 months, largely defined by sleep spindles and amplitude of EEG, have been correlated with behavioral outcome at 1 year (Crowell et al. 1982). Those infants with the most adult-like sleep stages, and therefore the most mature sleep spindle activity, had the best performance on an infant test at 1 year. It is, therefore, not surprising that EEG patterns in this study with sleep spindles, 536 (LVSp) and 538 (HVSp), are important discriminators of our 5 risk-outcome groups.

These studies indicate that the infants with a wide variety of risk factors and neonatal abnormalities show significant shifts in the magnitude and location of power and coherence of EEG when compared with normal controls. These changes, though varying greatly across these infant groups, are different than the more constant findings in normal infants. It would appear that biological stresses disrupt the organization of brain electrical activity in unsystematic ways. These disruptions of organization are not always readily apparent in the visually analyzed EEG patterns, but may only be detectable with computer analysis. This would be especially true of the coherence within and across hemispheres of EEG patterns.

It is easier to obtain correct classifications, such as were reported in the current retrospective study or postdictive studies, than in prospective studies. We now plan to use this technique on the remainder of the subjects in our study in a prospective predictive analysis. It will also be important to use the same discriminant criteria in a new study of newborn infants with different kinds of neonatal difficulties and cared for in a number of nurseries. This will determine if the power spectral criteria used in our study are generalizable to other neonatal and infant situations.

Résumé

Analyse du spectre EEG de nouveau-nés et suites comportementales à l'âge de cinq ans

La puissance spectrale et l'analyse discriminative ont été utilisées pour comparer des enregistrements EEG obtenus chez des nouveau-nés à terme puis à l'âge de 3 mois. Cinq groupes ont été constitués en fonction des risques et des suites comportementales: (1) sains et à terme; (2) sains prématurés avec suites normales; (3) prématurés malades avec suites normales; (4) prématurés malades avec retard de développement; (5) prématurés malades avec suites neurologiques. Les échantillons enregistrés à terme ont été identifiés comme appartenant au bon groupe avec une précision de 52 à 70% (20% étant le niveau chance pour chacun des 5 groupes). La précision a varié avec les 4 classes de pattern EEG utilisé. Les sujets ont

également été classés individuellement dans leur bon groupe à quelques exceptions près. Un succès semblable a été obtenu avec des échantillons EEG enregistrés à l'âge de 3 mois.

La caractéristique discriminative dominante de la puissance spectrale concernait les modifications entre cohérence intra- et inter-hémisphérique, ainsi qu'une augmentation de la puissance surtout dans les fréquences moyennes et hautes. Ainsi, l'analyse par ordinateur d'échantillons EEG à l'aide d'éléments non identifiables à l'observation visuelle, a fait la différence entre nouveau-nés à risques et ceux qui ne l'étaient pas et a aussi permis de séparer en fonction des suite bonnes ou mauvaises, les nouveau-nés qui avait eu d'importantes complications médicales néonatales.

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