Minor neurological signs and developmental performance in high risk children at preschool age

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The aim of this study was to establish correlations between minor neurological findings and developmental performance. A cohort of 72 preschool children was studied (38 females, 34 males; mean age 3 years 8 months, SD 1 year 2 months, range 2 to 5 years) who were considered to be at high risk due to placental insufficiency. The cohort was divided into four categories of neurological status: (1) minimal cerebral palsy (MCP) with independent walking before age 2 years; (2) Amiel-Tison triad (ATT) including imbalance of passive axial tone, phasic stretch reflex in triceps surae, and cranial signs, particularly on the squamous suture; (3) intermediate with one or two of the three ATT signs; and (4) absence of neurological findings. Six subscales of the Griffiths Mental Developmental Scales assessing locomotion, eye–hand coordination, interpersonal skills, language, performance, and practical reasoning were administered. Significant differences were found according to neurological status in three specific domains of development: coordination (F=2.84, p=0.04), language (F=3.65, p=0.02), and practical reasoning (F=3.62, p=0.02). In addition, significant differences were also found in language (L) and practical reasoning (R) performances according to the side of the abnormal stretch reflex: bilateral stretches (L=87.8; R=75.3) or an isolated right stretch (L=95.3; R=83.6) are more strongly associated with impaired developmental performances than an isolated left stretch (L=101.3; R=88.2) with F=2.94; p=0.04 for language and F=3.00, p=0.04 for practical reasoning. We concluded that a short neurological examination, easily performed by pediatricians and family practitioners, can identify permanent markers of minor brain damage occurring before, during, or soon after birth and so anticipate consequences.

The correlation between the location and size of a brain lesion visible on imaging with neurological signs and symptoms and, eventually, a resulting dysfunction is universally accepted. However, when cerebral imaging is 'within normal limits', many neurologists still hesitate to consider 'infraradiological' brain damage as responsible for minor brain dysfunction. In fact, there was a reluctance to accept correlations between mild lesion, mild neurological signs, and mild cerebral dysfunction even before cerebral imaging existed. This explains why the work of Alfred A Strauss in the late 1940s on the 'brain-injured child syndrome' was criticized and almost forgotten until a recent thoughtful review (Accardo 1997). Rapin (1982) introduces her book *Children with Brain Dysfunction* with this sentence: 'Despite stunning technical advances such as computerised tomography scanning, frequency spectrum analysis of electroencephalogram, evoked responses, and others just over the horizon, neurological diagnosis continues to depend on the clinical evaluation of patients' (p 9). Although MRI and magnetic resonance spectroscopy are now available, this statement made 20 years ago is still relevant.

In a recent study, three neurological signs were measured: two of these signs refer to passive tone (imbalance in axial tone and phasic stretch reflex in triceps surae) and the third concerns cranial sutures (Amiel-Tison et al. 1996). Comparing 14 children showing at least two of these three signs with matched control children, the study showed an association between these signs and neuropsychological outcome at 4 years of age. Therefore, these three signs, referred to here as the Amiel-Tison triad (ATT), could be of particular interest in documenting the relation between mild brain damage and learning disabilities.

The aim of the present study was to analyze the relation between this triad of minor neurological signs and the developmental performances of a larger cohort of high-risk children based on their antenatal history. Identifying a relation between easily measured clinical signs and developmental outcome could have many uses.

Method

PATIENTS

The studied cohort consisted of 72 preschool children (38 females, 34 males; mean age 3 years 8 months, SD 1 year 2 months, range 2 to 5 years) who participated in a larger ongoing study of the impact of maternal placental insufficiency on subsequent neurodevelopmental outcome of children. Selection criteria and data collection have been described in detail elsewhere (Fouron et al. 2001). In brief, all patients, seen at the Fetal Cardiology Unit at Hôpital Sainte-Justine, Montreal, Canada from January 1991 to June 1998, whose computerized chart included an abnormal umbilical Doppler velocity waveform were considered admissible for the study. Exclusion criteria were: gestational age (GA)<29 weeks at birth; patients living outside the Metropolitan Montreal area; families which did not speak French at home (to exclude bias in the developmental assessments which were carried out in French); chromosome disorders; congenital malformations; consanguinity; and evidence of socio-familial problems (e.g. drug addiction, alcoholism, mental illness, receipt of welfare, and previous history of physical abuse). The last ultrasonographic studies had to have been recorded within 2 weeks of delivery. Both singletons and multiple births were included. Children had to be

aged between 2 and 5 years at the time of assessment. The hospital's ethics committee on human research approved the protocol of the investigation which involved annual neurological and developmental assessments. Parents of all participants signed an informed consent form.

NEUROLOGICAL EXAMINATION

The neurological assessment described in Amiel-Tison and Gosselin (2001) was used. It is a continuation of the method used for the first year of life (Amiel-Tison 1976) and is traditional in nature: growth parameters, deep tendon reflexes, cranial suture status, primary reflexes, and postural reactions are examined. Due to the influence of the French school in the development of this assessment, particular importance is given to the evaluation of passive muscle tone. This has been thoroughly studied by Thomas and Saint-Anne-Dargassies (1952). The entire examination can be completed in 15 minutes. Interpretation of findings to define normal development and neuromotor abnormalities relies on the pattern of maturation in two distinct motor control systems: the subcorticospinal system (lower system) and the corticospinal system (upper system control), as reviewed elsewhere (Sarnat 1984, Amiel-Tison and Gosselin 2001). When the upper system control is altered due to damage in the cerebral hemispheres, the response to rapid stretching will change with two degrees of severity: the first response (phasic) is brisk and of short duration as the resistance quickly dissipates; a few clonic movements often occur with increased resistance. The second response (tonic) is more marked and protracted and is referred to as spasticity. Also, imbalance in passive muscle tone of the trunk is observed when comparing ventral flexion with dorsal extension: normally flexion is greater or equal to extension (more extension than flexion is abnormal at any age). In addition, damage in the cerebral hemispheres may interfere with head growth and cranial suture status. A ridge on the squamous suture due to overlapping of the bones (parieto-temporal suture located above the ear) may be detected by palpation (Fig. 1).

There is consensus on the clinical definition of cerebral palsy (CP; Mac Keith and Polani 1958). Unfortunately, milder signs that belong in the same pathophysiology have not been widely recognized. Categorization according to the nature and associations of neurological and cranial signs is proposed here (Table I). This categorization has emerged from years of practice with the clinical method described above. 'Minimal cerebral palsy', a term borrowed from Capute and Accardo (1991), is confirmed when uni- or bilateral tonic stretch reflex, with or without other abnormalities and no or moderate delay in independent walking are present. The ATT refers to the association of uni- or bilateral phasic stretch reflex, imbalance of passive axial tone as well as squamous ridges. Neurological status is considered intermediate when one or two of the three signs described in the triad are detected. All signs usually appear within the first 18 months of life (imbalance of passive tone in the trunk very early in life, stretch reflex from 6 to 18 months, squamous ridge within the first months). The first two signs are persistent whereas the squamous ridge may be permanent or regressive with remoulding after 2 years of age (Amiel-Tison et al. 1996).

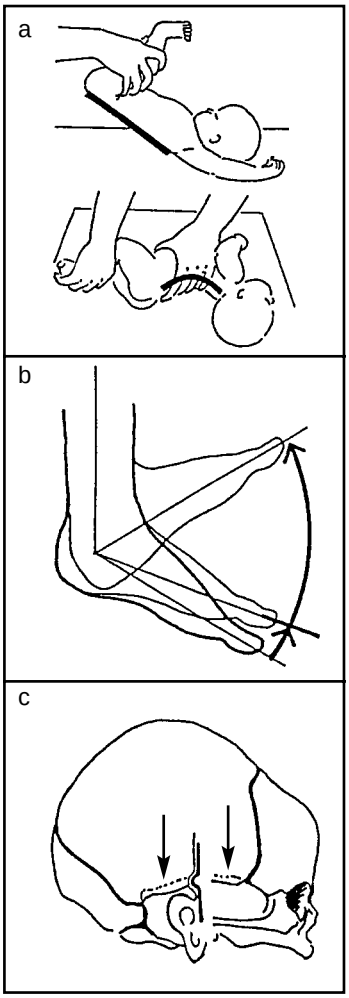

Figure 1:
(a) imbalance in passive muscle tone of trunk with excessive extension compared with flexion; (b) phasic stretch during rapid dorsiflexion of foot; (c) squamous ridge (indicated by arrows).

DEVELOPMENTAL ASSESSMENT

The Griffiths Mental Developmental Scales (Griffiths 1954) were used to assess skills in six different areas of development: locomotion, eye–hand coordination, interpersonal skills, language, performance, and practical reasoning. Subscale quotients for each area were calculated independently as well as a global developmental quotient (DQ) which is obtained by averaging scores from all subclasses. The global score was used only to analyze the effect of some potential confounders. However, all other analyses were performed with the individual scores obtained for each subscale to determine which domains of development were more closely related to the neurological signs. Age of independent walking (corrected for prematurity) was determined by asking the mother the age at which her child walked a few steps without support for the first time. All mothers remembered the exact date or at least the month when the child began to walk.

TESTING CONTEXT

Two independent examiners previously trained in the method performed neurological assessments and developmental evaluations. The same examiners performed the evaluations for the whole cohort. They did not have access to the medical charts of the children nor to their previous or current evaluation results. Corrected age was used if children were assessed at 2 years of age. After that age, chronological age was used. In a majority of children, the neurological assessment was completed before the developmental evaluation so that the child

could become more familiar with the testing environment. Parents attended both evaluations and were asked to complete pretested forms on socio-demographic information and rehabilitation interventions received by the child since birth.

STATISTICAL ANALYSES

Two sets of analyses were performed: the first examined the relation between the four previously defined neurological categories and developmental performance. The second set examined the relation between characteristics of the response to rapid dorsiflexion of the foot, essentially the affected side, and developmental performances.

Differences in developmental performance between the four groups defined by the clustering of neurological signs were investigated using ANOVA. Numbers were too small to carry out ANCOVA controlling for potential confounders. To determine whether the neurological status remained a significant predictor of global developmental performance after controlling for confounders, we used multiple linear regression. Finally, ANOVA was also performed to compare developmental performances among groups defined by characteristics of the response with rapid dorsiflexion of the foot. Statistical significance was set at $p<0.05$. All analyses were performed with SPSS (version 8).

Results

CLUSTERS OF MINOR NEUROLOGICAL SIGNS

Signs compatible with MCP were found in eight children (11%) and ATT was detected in 15 children (21%). Signs were intermediate in 20 children (28%). Normal neurological status was found in 29 children (40%). In the MCP category, only one child had bilateral tonic stretches, three had unilateral tonic stretch with contralateral phasic stretch, and four showed unilateral left tonic with contralateral normal response to stretch. The axial tone was within normal limits in only one child. All children had cranial signs. In the ATT category, bilateral phasic stretches were present in three children while unilateral left phasic stretch was obtained in eight and unilateral right phasic stretch in four. All children had imbalance of axial tone and cranial signs. In the intermediate category, nine children had at least one phasic stretch. In two children, the abnormal response to stretch was bilateral. In three children, the stretch was associated with axial tone imbalance while it was associated with cranial signs in five children. Imbalance of axial tone and cranial signs were observed in association in four children while squamous ridges combined with microcephaly were noted in seven children. There were no neurological signs in the group with normal neurological status.

CHARACTERISTICS ACCORDING TO NEUROLOGICAL STATUS

Clinical characteristics are described in Table II. Mean GA was 33.1 weeks (SD 2.3), range 29 to 39 weeks and mean birthweight (BW) was 1523 g (SD 451, range 650 to 2460 g). As the main study concerned maternal placental insufficiency, intrauterine growth restriction (IUGR) was overrepresented in the participants with almost 50% of the children being at least 2SDs below the mean at birth (35 of 72). Although mean GAs were comparable between groups, the average BW for the ATT group tended to be lower than for the other groups; IUGR was more frequent in this group. Other data (not shown) showed that 70 infants were inborn and two were transferred from other hospitals within the first 24 hours of life. Average number of days in NICU was variable accross groups. Lack of homogeneity of variance prevented any intergroup comparisons. Distribution of all the other variables, including the sociodemographic variables, was similar among groups.

NEUROLOGICAL STATUS AND DEVELOPMENTAL PERFORMANCES

The four groups were significantly different in three domains of development: coordination ($F=2.84$, $p=0.04$), language ($F=3.65$, $p=0.02$), and practical reasoning ($F=3.62$, $p=0.02$) as shown in Table III. Coordination was clearly lower, especially for the MCP group (mean 88.8, CI 78.4–99.2) with a deviation of almost 12 points from the mean obtained in the normally developing group (mean 100.2, CI 96.9–103.5). With regard to language, the mean scores obtained for each group were clearly distinct with an almost 6-point difference between each group showing any kind of neurological signs (MCP, mean 88.8, CI 77–100.6; ATT, mean 94.5, CI 88.9–100.1; intermediate, mean 100.4, CI 94.7–106.1). The normally developing group had a mean of 104.1, (CI 99.3–108.9) which was also distinct but closer to the results obtained by the intermediate group. With respect to practical reasoning, performances were comparable for the MCP and the ATT groups, (mean 80.2, CI 65.4–95 versus mean 81.4, CI 73.7–89.1) but distinct from those of intermediate and normal groups (mean 89.2, CI 83.1 –95.3 versus mean 95, CI 90.2–99.8). Mean for the entire group was rather low, 88.2, (CI 84.4 –92).

Performances on the locomotion subscale were comparable among the groups, although the average for the entire group was below 100: mean 95.1 (CI 93–97.2). Finally, the performance and the interpersonal domains were not significantly affected by the presence of minor abnormal neurological signs but the scores tended to decrease for both domains, depending on the severity of the signs. With respect to age at independent walking (see Table III), there were significant differences between groups ($F=5.90$, $p=0.001$). Age at acquisition was

Table I: Categorization according to nature and associations of neurological and cranial signs

Categories	*Neurological signs*
Minimal cerebral palsy	Uni- or bilateral tonic stretch reflex with or without other abnormalities Independent walking before 2 years corrected age
Amiel-Tison triad	Uni- or bilateral phasic stretch reflex, imbalance of passive axial tone, and squamous ridges
Intermediate	1 or 2 of the following signs: phasic stretch or imbalance of passive axial tone or squamous ridges combined with microcephaly
Normal	No neurological signs or isolated squamous ridges

delayed with an almost similar age for MCP (mean 14.1, CI 11.6–16.6) and ATT (mean 14, CI 12.8–15.2) groups. Walking was acquired earlier in the other two groups (intermediate mean 12.9, CI 12.2–13.6 and normal, mean 11.7, CI11.1–12.3). Total DQ for the entire cohort was 98.1 with a SD 8.2, i.e. not significantly different from the normative values defined for the Griffiths scales (total DQ 100, SD 12.76). It also has to be underlined that the normally developing group obtained higher scores in all six domains assessed by the Griffiths scales than the other groups. The intermediate group tended to be distinct from the normally developing group with deviations varying from 0.8 (locomotion) to 5.8 points (practical reasoning).

We also carried out an analysis on the global development quotient whereby the effect of neurological status was evaluated controlling for other known predictors of developmental outcome, such as sex, IUGR, GA, and maternal level of education. Neurological status remained an overall statistically significant contributor to the global outcome (ATT versus MCP β mean 3.53, CI 2.87–9.94; Intermediate versus MCP β mean 8.26, CI 2.20–14.32; and normal versus MCP β mean 11.51, CI 5.82–17.20). Thus, it could be interpreted that the global quotient increased by 3.53 units in the ATT group in comparison with the MCP group; by 8.26 units in the intermediate group and by 11.5 units in the normally developing

Table II: Characteristics of participants according to neurological status

Characteristics	*MCP n=8*	*ATT n=15*	*Intermediate n=20*	*No signs n=29*	*Total n=72*
Singletons, *n*	4	8	9	18	39
Sex, M:F	3:5	4:4	13:7	14:15	34
Gestational age, wk					
Mean (SD)	33 (2.3)	33.5 (2.4)	32.3 (1.7)	33.5 (2.5)	33.1 (2.3)
Range, wk	30–36	29–37	29–35	29–39	29–39
< 33 weeks, *n*	3	5	9	11	28
Birthweight, g					
Mean (SD)	1601 (401)	1378 (532)	1543 (426)	1578 (436)	1523 (451)
Range	1210–2195	650–2460	700–2420	890–2320	650–2460
IUGR, *n*	4	12	7	13	36 (50%)
Emergency Cesarian section, *n*	1	4	3	7	15 (20.8%)
Assisted ventilation, *n*	–	4	4	2	10 (13.9%)
Maternal age, y					
Mean (SD)	31.9 (3)	28.8 (4.2)	30.2 (3.5)	29(5.3)	29.5 (4.4)
Range	28–37	20–37	22–37	21–40	20–40
Maternal education <12 y (*n*)	4	5	8	14	31 (43.1%)
Income <$30000, *n*	3	3	4	6	16 (22.2%)
Day care, *n*	3	7	11	15	36 (50%)
Age at follow-up, y					
Mean (SD), y:m	3:10 (1:2)	3:11 (1:2)	3:10 (1:1)	3:6 (1:2)	3:8(1:2)
Range	2:1–5:1	2:1–5:5	2:1–5:5	2–5:5	2–5:5

MCP, minimal cerebral palsy; ATT, Amiel-Tison triad; IUGR, intrauterine growth restriction.

Table III: Neurological status and developmental skills (Mean, 95% CI)

Developmental domain	*MCP n=8*	*ATT n=15*	*Intermediate n=20*	*No signs n=29*	*Total n=72*
Locomotion	91.6	91.4	96.3	97.1	95.1
	85.2–98	86–96.8	92.9–99.7	93.9–100.3	93–97.2
Coordination[a]	88.8	94.5	96.7	100.2	96.8
	78.4–99.2	89.7–99.3	91.8–101.6	96.9–103.5	94.3–99.3
Performance	99.5	103.3	104.4	108.5	105.2
	88.2–110.8	97.1–109.5	98.4–110.4	103.9–113.1	102.1–108.3
Language[a]	88.8	94.5	100.4	104.1	99.4
	77–100.6	88.9–100.1	94.7–106.1	99.3–108.9	96.2–102.6
Practical reasoning[a]	80.2	81.4	89.2	95	88.2
	65.4–95	73.7–89.1	83.1–95.3	90.2–99.8	84.4–92
Interpersonal/social	93.5	98.4	99.3	103.5	100.2
	83.9–103.1	92.5–104.3	94.5–104.1	98.8–108.2	97.3–103.1
Independent walking (mo)[a]	14.1	14	12.9	11.7	12.8
Range	11.6–16.6	12.8–15.2	12.2–13.6	11.1–12.3	12.3–13.3

[a] $p<0.05$.

group. The relatively small number of study participants made it impossible to determine whether the effect of the neurological status was homogeneous across the levels of the predictor variables or if there was statistical interaction.

RESPONSE TO RAPID STRETCHING AND DEVELOPMENTAL PERFORMANCE

Whether tonic or phasic, an abnormal stretch reflex in the triceps surae reflects the presence of a distal spasticity of variable degrees, therefore, we analyzed this in relation to developmental performance. As shown in Table IV, bilateral abnormal responses were found in nine children (5 phasic–phasic; 1 tonic–tonic; 3 phasic–tonic); unilateral abnormal response was found in 23 children (19 phasic and 4 tonic). Coordination was lower in the three groups of children who were symptomatic compared with children who were asymptomatic; however, this difference was not statistically significant. Language quotients were as follows: bilateral, mean 87.8 (CI 76–99.6); right, mean 95.3 (CI 87.3–103.3); and left, mean 101.3 (CI 95.7–106.9). This last result was comparable with the one obtained for the group without an abnormal stretch (mean 101.7, CI 97.6–105.8). The differences were statistically significant ($F=2.94$, $p=0.04$). Distribution of the quotients for the practical reasoning domain followed an almost similar trend: bilateral, mean 75.3 (CI 59.6–91); right, mean 83.6 (CI 74–93.2); and left, mean 88.2 (CI 81.4–95). However, the mean score for the normal group was higher (92.1, CI 87.7–96.5). The differences were statistically significant ($F=3$, $p=0.04$). Independent walking was delayed when there was a unilateral abnormal stretch (left, mean 14 CI 12.7–15.3; right, mean 14.8, CI 13.4 to 16.2; no stretch, mean 11.9, CI 11.4–12.4); a bilateral abnormal response did not seem to have the same impact (mean 12.8, CI 11.5–14.1). Differences were statistically significant ($F=6.36$, $p=0.001$).

Discussion

At this time, any valid comparison with results obtained in other studies seems difficult to accomplish due to the lack of uniform methodology. For many years, neurological outcome in high-risk children has been discussed in terms of major impairment and normality. Major neurological impairment usually refers only to CP.

A number of attempts have been made to define minor neurological impairments often referred to as 'soft signs' and described in various textbooks (Touwen and Prechtl 1970, Rapin 1982). Very often, however, this term refers to signs that are difficult to elicit or to interpret because they are rather evasive and non-specific. Denckla (1979) proposed a clear distinction between those 'soft signs' that, even though subtle, are abnormal at any age (therefore reflecting a brain lesion) and those that would be normal if found in a younger child (possibly reflecting a maturational lag). Though conceptually essential, her description of signs is a mixture of neurological signs and functional consequences. In the same way, Capute and Accardo (1991) defined minimal CP as motor deviancy but without motor delay. They stressed the important notion of the motor spectrum concept, indicating that even mild motor dysfunction indicates increased risk for learning disabilities.

Transient dystonia, as defined by Drillien (1972), refers to various tone abnormalities noticed within the first year of life which can be associated with behavioural disturbances. For Drillien, these early signs have a tendency to vanish as CNS maturation is progressing. However, they are correlated to a higher risk of school failure (Drillien et al. 1980). In 1983, a cluster of signs labelled as 'transient neurological abnormalities,' closely related to Drillien's transient dystonia, was identified (Amiel-Tison et al. 1983). Risk of school failure has been found to be higher in children who showed some transient signs during the first 18 months of life compared with normally developing individuals. The transient character of these signs, however, has been questioned (Amiel-Tison et al. 1994): their discontinuation could be interpreted as the result of maturation which alters the characteristics of the deficit observed at each age. When identification of minor signs is clearly separated from their functional consequences, these signs appear permanent. Only the functional consequences change.

In applying a more systematic method of evaluating high-risk children, the Amiel-Tison triad has been identified as described above. Associations with neuropsychological outcome have already been demonstrated in a small cohort (Amiel-Tison et al. 1996). Our current results contribute to the validation of this cluster on a larger sample in relation to language and practical reasoning skills. Associations with

Table IV: Bilateral or unilateral stretches and developmental skills (Mean, 95% CI)

Developmental domain	*Bilateral*	*Right*	*Left*	*Normal*
Locomotion	91	94.7	94.7	96.2
	84–98	84.2–105.2	90.4–99	93.6–98.8
Coordination	94.1	95	93.3	99.2
	82.9–105.3	85.3–104.7	89.0–97.6	96.3–102.1
Performance	107.9	100.2	102.4	106.6
	97.2–118.6	90.4–110	94.7–109.1	102.7–110.5
Language[a]	87.8	95.3	101.3	101.7
	76–99.6	87.3–103.3	95.7–106.9	97.6–105.8
Practical reasoning[a]	75.3	83.6	88.2	92.1
	59.6–91	74–93.2	81.4–95	87.7–96.5
Interpersonal/social skills	94.8	100.5	100.9	101
	87.1–102.5	88.1–112.9	95.4–106.4	97.1–104.9
Independent walk (mo)[a]	12.8	14.8	14	11.9
Range	11.5–14.1	13.4–16.2	12.7–15.3	11.4–12.4

[a] $p<0.05$.

other domains, such as motor components, are sparser and remain mostly statistically non-significant. These results may be due to the developmental scales' content. Hempel (1993) has emphasized the importance of the qualitative changes in the toddling period. Standard developmental scales rarely assess these qualitative changes but rather appreciate predominantly the quantitative ones. The minor neurological signs that have been retained in our study should have a significant impact on the quality of the skills.

Moreover, the categorization proposed in our study allows the description of a continuum in the degree of minor neurological impairments sharing the same pathophysiological background. In fact, the observed distribution in each group, with a progressive decrease in the number of cases from mild to severe categories, supports the concept of a lesional continuum across the categories. There were still 28% of the children with abnormalities who could not be classified. It has to be noted that this group of children with various signs but no cluster of signs showed developmental performances that slightly differed from the control group. The absence of CP in our cohort can probably be explained by the source of study participants.

From a pathophysiological point of view, the development of the myotatic reflex of the lower extremities has been studied (Leonard et al. 1995). Outcome of infants with ankle clonus within the first year of life has been shown to be rather poor (Futagi et al. 1997). A hyperactive spinal stretch reflex is the underlying mechanism of both ankle clonus and phasic stretch, which are often found concomitantly.

In this respect, one major aspect of our findings is the impact of the side of the abnormal response to stretch in the triceps surae: language and practical reasoning are significantly lower when there is an abnormal response in the right side while performance in those domains remains above significance level when the left side is involved. These results, especially in regard to language abilities, could be explained by the localization of speech functions in the left hemisphere.

Conclusion

Longitudinal studies among high-risk infants all have the same goal, namely, the earliest identification of children who may show problems in later development. Current data contribute to the validation of a cluster of minor neurological and cranial signs that are easy to detect with a systematic examination within the first 2 years of life. Their correlations with language and practical reasoning skills could be of particular interest to identify, more specifically, children who are at risk for learning disabilities. In other words, the goal is not to detect minor variations in test scores but to alert clinicians that a child has signs that indicate past neurological insult and possible future learning problems. Early identification of such signs could lead to a better use of intervention resources in the community. Their persistence over the years could also allow retrospective analyses in children who fail at school by providing a permanent marker of the minor brain damage which occurred in them before, during, or soon after birth.

In the absence of MRI in the neonatal period or later in this cohort, we cannot affirm that the neurological assessment is more sensitive than imaging techniques. However, daily experience suggests that not all structural brain changes are currently visible or easily identified. Moreover, a basic neurological assessment is indispensable in any child with neurobehavioral problems or learning difficulties and appears sensitive enough to identify an at-risk group. This examination is short, easy to do, less expensive, and less invasive than an imaging study and could be readily used by pediatricians and family practitioners.

Accepted for publication 16th November 2001.

Acknowledgements

This study was supported by grants from the Medical Research Council of Canada and Sainte-Justine Hospital Research Center.

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