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Motor and sensory dysfunctions in children with mental retardation and epilepsy

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The aim of this study was to assess motor and sensory functions in a population-based series of 88 mentally retarded children with epilepsy. A new standardized physiotherapy protocol was developed for the heterogeneous population of children with epilepsy; the Cailler–Azusa scale was also found to be useful. For children with cerebral palsy, the gross motor function measure was used. Sensorimotor impairments, resulting in disabilities and handicap, were found to be very common but often overlooked and neglected. Sensorimotor dysfunctions need to be identified in order to provide rational training, understanding and care to children with epilepsy and mental retardation.

Key words: epilepsy; mental retardation; motor impairment; children; disability; handicap.

INTRODUCTION

Children with epilepsy often have 'hidden' dysfunctions in gross and fine motor function, balance, coordination and sensory parameters.

The aim of this study was to evaluate motor and sensory impairments, disabilities and handicaps in a population of mentally retarded children with active epilepsy.

Epilepsy and mental retardation represent major neuroimpairments in the childhood population. Mental retardation is the most common additional neuroimpairment in children with epilepsy, found to be present in over a quarter of the children studied by Forsgren *et al*[1]. Other neurodeficits with an excess prevalence in children with epilepsy are cerebral palsy (CP), visual loss, hearing impairments, behavioural, attentional and psychiatric problems. In these children, as well as in the group without major neurodeficits, impairments in motor and sensory functions are frequent[2]. These impairments can be caused by the underlying brain lesion, the epilepsy itself, the medical treatment of the epilepsy or, most commonly, by a combination of these factors. The dysfunctions must be identified in order to provide rational training, understanding and care.

In this study, two dichotomies, mild vs. severe mental retardation and intractable vs. controlled epilepsy, were used to analyse motor and sensory functions in a population based group of children with mental retardation and active epilepsy.

DEFINITIONS

Epileptic seizure was defined according to the International League Against Epilepsy[3] as a clinical manifestation presumed to result from an abnormal and excessive discharge of a set of neurons in the brain. Epilepsy (Ep) was defined as two or more epileptic seizures, unprovoked by any immediate, identified cause[4]. Active Ep was defined as Ep with one or more epileptic seizures during the 5-year period prior to the prevalence day, regardless of antiepileptic drug (AED) treatment[4]. Intractable Ep was defined as epilepsy with more than 20 seizure days a year in spite of adequate AEDs. Mental retardation (MR) was defined as mild in children with IQ 50–70 and severe if IQ was <50. Cerebral Palsy (CP) was defined as 'a non-progressive disorder of movement and posture due to a defect or a lesion of the immature brain[5]. Impairments concern abnormalities of body structure and appearance and organ or system function, resulting from any cause; in principle, impairments represent disturbances at the organ level. Disabilities reflect the consequences of impairment in terms of functional performance and activity by the individual; disabilities thus represent distur-

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bances at the level of the person. Handicap concerns the disadvantages experienced by the individual as a result of impairments and disabilities; handicap thus reflects interaction with and adaptation to the individual's surroundings[6].

MATERIAL

A population based study by Steffenburg *et al*[7,8] including 48 873 children born from 1975 to 1986 and living in the city of Gothenburg revealed 378 children with MR. The prevalence of MR was 7.7 per 1000 children. Mild MR was present in 4.8 and severe MR in 2.9/1000.

Epilepsy was found in 98 of the 378 mentally retarded children (26%). Of the children with mild MR, 35 (15%) had epilepsy, compared with 63 (44%) of the children with severe MR.

The median age for the onset of the Ep was 1.6 year (range, 1 month to 9 years). The aetiology of the Ep was considered prenatal in 55%, perinatal in 15% and postnatal in 12%. The cause was unknown in 17% of the children. The dominating seizure types were partial and tonic–clonic.

Forty-five children (51%) had intractable Ep. There was a difference in the distribution of intractable Ep, with significantly more ($P < 0.01$) cases in the severe MR children.

CP was present in 42, visual impairments in 24 and autism in 24 of the 98 mentally retarded children with Ep.

Assessment of motor and sensory function was performed in 88 of the 98 children, 45 boys and 43 girls, 31 with mild MR and 57 with severe MR. Five children had died before the clinical investigation, one had moved from Gothenburg and the parents of four children did not want to participate in the study. Four of the excluded children were mildly and six severely mentally retarded; five had CP.

The median age at the assessment was 12 years (range, 6–19).

Severity of the Ep and MR is shown in Table 1. The corresponding distribution in the CP cases is shown in Table 2.

Table 1: Severity of the epilepsy and mental retardation in 88 children

	Intractable Ep	Controlled Ep	Total
MMR	10 (32%)	21 (68%)	31 (35%)
SMR	35 (61%)	22 (39%)	57 (65%)
Total	45 (51%)	43 (49%)	88

Ep, Epilepsy; MMR, mild mental retardation; SMR, severe mental retardation.

Table 2: Distribution of cerebral palsy in 88 children with mental retardation and epilepsy

	Intractable Ep	Controlled Ep	Total
MMR	1	4	5
SMR	19	13	32
	20 (54%)	17 (46%)	37

Ep, epilepsy; MMR, mild mental retardation; SMR, severe mental retardation.

METHODS

All children were evaluated with a validated American test, the Cailler–Azusa scale[9]. The test is an age-equivalent developmental motor assessment tool which measures the age at acquisition of motor milestones. Only the subscale for evaluation of motor development (postural control, locomotion, fine motor development and visuomotor control) was used. The children were also evaluated with a new physiotherapy protocol[2], measuring gross motor function, balance, coordination, strength, range of motion, velocity, fine motor function, sensation, perception and performance in neurological tests. The quality and level of sensorimotor function were scored on a four-point scale from 0 to 3: 0 = no function, 1 = poor, 2 = fair, and 3 = good (normal). The scores were defined in detail for all items and the scoring system made it possible to define and quantify dysfunctions in the child and define mild, moderate and severe dysfunctions. The reliability for the new assessment protocol has been tested and found to be good ($r = 0.9$)[10]. A validation study is currently being performed.

The children with CP syndromes were tested with the gross motor function measure (GMFM), a valid and reliable measure of gross motor function in CP[11]. GMFM is a selection of 85 items arranged in five groups: (1) lie and roll; (2) crawl and kneel; (3) sit; (4) stand; and (5) walk, run and jump. All items can be accomplished by a normal 5-year-old child.

The evaluation was performed by one of the authors (EB) in the physiotherapy department at the Children's Hospital, or in the schools or homes of the children.

The frequency of physiotherapy treatments was recorded.

Classification of handicap according to the World Health Organization manual[6] was performed. This classification is based on a nine-point scale, grading the level of orientation, physical independence, mobility, occupation, social integration and economic self sufficiency. The score 0 indicates no handicap, 1–3 mild handicap,

4–6 moderate handicap, and 7–8 severe handicap. The scale was adjusted to Scandinavian children from the age of 6 years[12].

RESULTS

Motor development

There were no children with an age equivalent motor and sensory developmental level. Motor developmental age was often very low [Fig. 1(a) and (b)]. Differences were found between the mild MR and the severe MR groups, and between intractable and controlled Ep. The developmental level was lowest in the severely mentally retarded children with intractable Ep, especially the fine motor function, with a difference of 18 months in the median value between the children with intractable versus controlled Ep.

Mild MR

For the children with mild MR, the median age at evaluation was 13 years (156 months). The developmental age was 72 months for locomotion and 60 months for postural control in children with intractable ep, vs. 72 months for the children with controlled Ep. Fine motor function was on a 72 months level for the children with controlled Ep and on a 75 months level for intractable Ep. Developmental median age for visuomotor control was 82 months for the children with intractable Ep and 84 months for those with controlled Ep.

Severe MR

For the children with severe MR, the median age at evaluation was 11 years (132 months). The developmental age for locomotion was 4 months for all and for postural control 6 months if the children had intractable Ep and 6.5 months for the children with controlled Ep. Fine motor function in the children with severe MR was on a 4-month developmental level in intractable Ep and an 8-month level in controlled ep. Differences were similar for visuomotor control, where the children with intractable Ep were on a 3-month developmental level and the children with controlled Ep on a 7-month level.

Impairments

Evaluation of sensorimotor impairments with the physiotherapy protocol revealed differences between and within the mild MR and severe MR groups. Severe impairments were most common in the severe MR group with intractable Ep [Tables 3(a) and (b)].

Mild MR

No or mild impairments were most common in the children with mild MR. Normal strength was

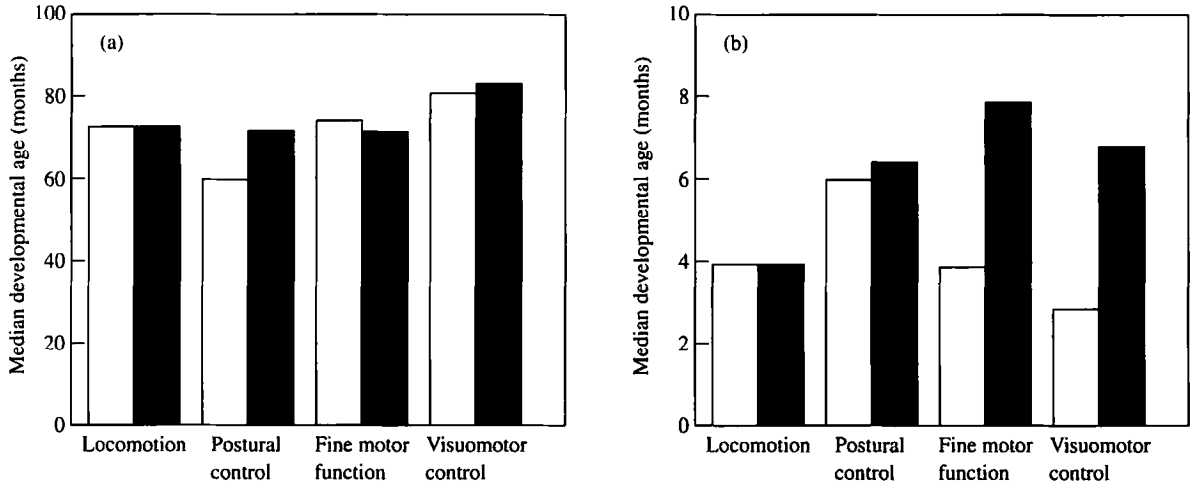

Fig. 1: Motor developmental age in children with (a) mild ($n = 31$) and (b) Severe ($n = 57$) mental retardation and epilepsy. Median age at evaluation 144 months. (a) □, Intractable Ep ($n = 10$); ■, controlled Ep ($n = 21$). (b) □, Intractable Ep ($n = 35$); ■, controlled Ep ($n = 22$).

Table 3(a): Sensorimotor impairments in 31 children with mild mental retardation and epilepsy

Impairment	Severe		Moderate		Mild		None	
	IE *n*	CE *n*	IE *n*	CE *n*	IE *n*	CE *n*	IE *n*	CE *n*
Strength	0	0	0	2	6	13	4	6
Range of motion	0	0	0	1	2	2	8	18
Sensation	0	0	1	2	3	8	6	11

IE, Intractable epilepsy ($n = 10$), CE, controlled epilepsy ($n = 21$).

Table 3(b): Sensorimotor impairments in 57 children with severe mental retardation and epilepsy

Impairment	Severe		Moderate		Mild		None	
	IE *n*	CE *n*	IE *n*	CE *n*	IE *n*	CE *n*	IE *n*	CE *n*
Strength	13	5	6	9	12	8	4	0
Range of motion	12	3	2	7	7	7	14	5
Sensation	12	4	1	7	6	11	16	0

IE, Intractable epilepsy ($n = 35$); CE, controlled epilepsy ($n = 22$).

found in 10 of 31 children with mild MR; four of them had intractable Ep. The median score was 2 (mild impairment). Range of motion was normal in 26 children, eight with intractable Ep and 18 with controlled Ep, median score 3 (normal or good). Sensation was normal in 17 children, six with intractable and 11 with controlled Ep, the median score being 3 (normal or good).

Severe MR

Among the the children with severe MR, normal strength was found in four of the 57 children. The median score was 1 (moderate impairment). Range of motion was normal in 19 children, 14 of whom had intractable and five controlled Ep. The median score was 2 (mild impairment). Sensation was normal in 16 children, though sensation was difficult to evaluate in the multihandicapped children. The median score was 2 (mild impairment).

Disabilities

Mild MR

The evaluation of the 31 children with mild MR revealed seven children with normal gross motor function, two of whom had intractable Ep. As to fine motor function, five children had a normal function, all with controlled Ep, the median score being 2 (mild disability). In the areas of coordination and balance, three children with normal performance were found; the median scores was 2 (mild disability). Six children had a normal perception, one with intractable Ep and five with controlled Ep; the median score was 2 (mild disability) [Table 4(a)].

Severe MR

Among the 57 children with severe MR, there were no children with normal gross motor function, fine motor function, coordination, balance or perception. The median score was 1 (moderate disability) for gross motor function and 0 (severe disability) for fine motor function, coordination, balance and perception [Table 4(b)].

Table 4(a): Sensorimotor disabilities in 31 children with mild mental retardation and epilepsy

Disability	Severe		Moderate		Mild		None	
	IE *n*	CE *n*	IE *n*	CE *n*	IE *n*	CE *n*	IE *n*	CE *n*
Gross motor function	0	0	1	3	7	13	2	5
Fine motor function	0	0	2	2	8	14	0	5
Coordination balance	0	1	5	7	5	10	0	3
Perception	1	0	4	4	4	12	1	5

IE, Intractable epilepsy ($n = 10$), CE, controlled epilepsy ($n = 21$).

Table 4(b): Sensorimotor disabilities in 57 children with severe mental retardation and epilepsy

Disability	Severe		Moderate		Mild		None	
	IE *n*	CE *n*	IE *n*	CE *n*	IE *n*	CE *n*	IE *n*	CE *n*
Gross motor function	18	5	12	15	5	2	0	0
Fine motor function	22	9	9	12	4	1	0	0
Coordination Balance	28	21	7	1	0	0	0	0
Perception	30	21	4	1	1	0	0	0

IE, Intractable epilepsy ($n = 35$), CE, controlled epilepsy ($n = 22$).

CP

The results from the GMFM in the CP cases showed the motor performance in per cent of normal for the age of 5. The mean percentage score for the children with mild MR was for area (1) (lie and roll) 90; area (2) (kneel and crawl) 78; area (3) sit 64; area (4) (stand) 56, and area (5) (walk, run and jump) 34. For the children with severe MR the scores were (1) 45, (2) 32, (3) 15, (4) 12 and (5) eight. The mean total gross motor function score was for mild MR 65% and for severe MR 22%. The mean percentage scores for the CP cases with intractable Ep were lower than for children with controlled Ep (Fig. 2).

Handicap

Differences were found between the children with mild and severe MR (Fig. 3). Children with severe MR had a significantly higher handicap score than the children with mild MR. The handicap was mild or moderate in all areas of the children with mild MR and severe in all areas but economic self-sufficiency for the children with severe MR. The median scores for the children with mild MR were for orientation 4, for physical independence 5, for mobility 2, for occupation 5, for social integration 3 and for economic self-sufficiency 2. For the children with severe MR, the handicap scores were higher; orientation and physical independence 6, mobility 7, occupation 6, social integration 7 and economic self-sufficiency 2.

There were also differences between intractable and controlled Ep. The median handicap scores of all children were lower for the children with controlled epilepsy. The mobility handicap score was 5 for the children with intractable Ep and 4 for children with controlled Ep. The occupational handicap score was 6 in the intractable Ep children and 5.5 in the children with controlled Ep (Fig. 4).

Physiotherapy

Physiotherapy was provided once a week for 46 children (52%). Of the 37 children with CP, all but one, with CP and mild MR, had physiotherapy on a regular basis. Ten children without CP, or 20% of that group, received physiotherapy (three with mild MR and seven with severe MR).

DISCUSSION

The aim of this study was to evaluate motor and sensory function in mentally retarded children with Ep in a population-based series. We found that sensorimotor dysfunctions were very common, but that they had frequently been overlooked.

Motor performance depends on the quality of the central nervous system and the mood and motivation of the individual. In children with MR, developmental retardation or deviation of the central nervous system limits the motor development. Forssberg[13] states that a

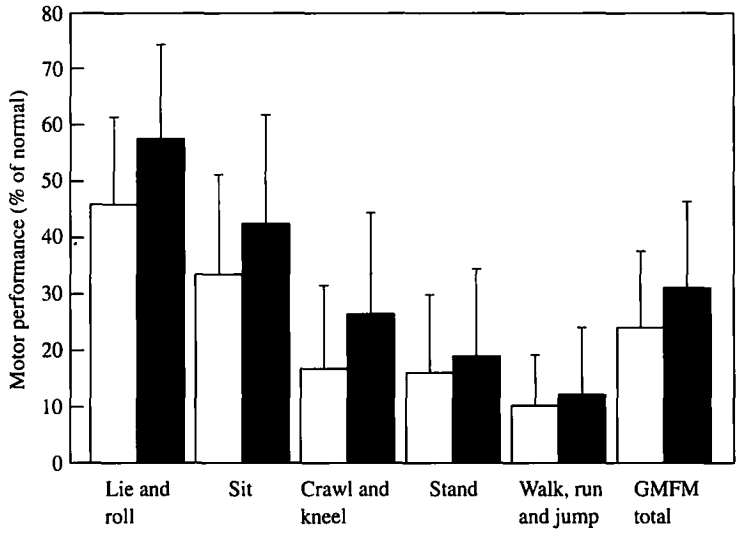

Fig. 2: Mean percentage scores with 95% confidence intervals for the gross motor function measure in 37 children with cerebral palsy, mental retardation and epilepsy. □, Intractable ($n = 32$); ■, controlled ($n = 5$).

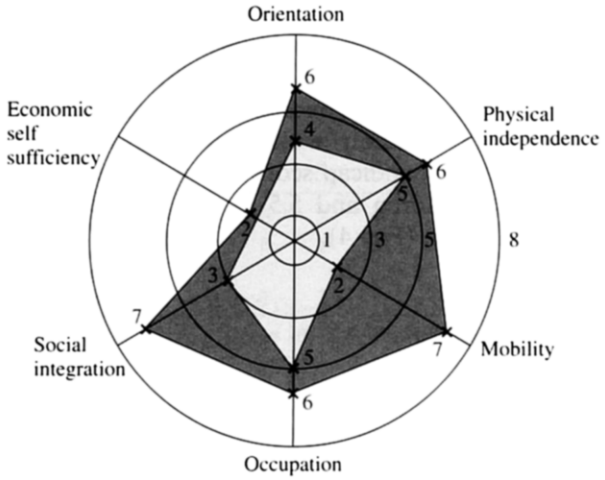

Fig. 3: Classification of Handicap (WHO) in 31 children with mild mental retardation and epilepsy (□) and 57 children with severe mental retardation and epilepsy (■). 0 = no handicap; 1–3, mild handicap; 4–6, moderate handicap; 7–8, severe handicap.

considerable part of the motor development is predetermined and governed by the maturation of specific neural mechanisms and their activity, in conjunction with sensory feedback, and that the brain has to reach a degree of maturity before it is ready to execute a certain skill. With few systems functioning, the sensory-motor afferents give the child very little input, which will result in poor body image and reduced activity. Children with MR also often lack motivation, which can aggravate their immature motor behaviour. Epilepsy interrupts brain function. The extensive neuronal interconnections within a local area of the cortex and between distant areas underlie the

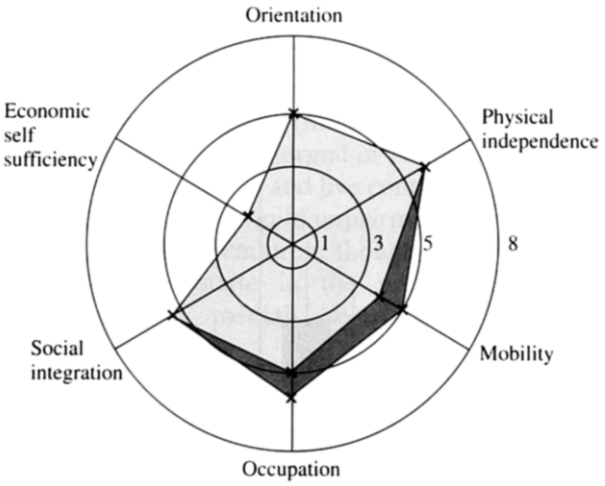

Fig. 4: Classification of Handicap (WHO) in 43 children with mental retardation and controlled epilepsy (□) and 45 children with mental retardation and intractable epilepsy (■). 0, no handicap; 1–3, mild handicap; 4–6, moderate handicap; 7–8, severe handicap.

extensive serial and parallel processing of sensorimotor information. Such connections, many of which are excitatory, may result in an abnormal synchrony of discharges in large groups of neurones[14]. Such synchronous interactions will cause an epileptic seizure that has serious functional consequences. When MR and Ep occur together in a child, the effects on sensorimotor functions may be deleterious. The impairments seem to have a multiplicative rather than an additive effect on the total handicap.

Epidemiological studies of children with Ep[15–21] and studies of mentally retarded children[1,22–26] provide some descriptions of the motor and sensory functions of the children, but these descriptions are sparse and the dysfunctions are not investigated in detail. Forsgren *et al*[1], in their study of children and adults with epilepsy and mental retardation, found some type of movement disorder in over 40% of cases. A Finnish study by von Wendt *et al*[17] of children with epilepsy showed that one or more additional handicapping condition, such as CP, MR, a visual or an auditory defect, was present in over 35% of the children and in a study of Swedish schoolchildren with mild MR, Hagberg *et al*[27] found epilepsy in 12% and CP in 9% of the children. Most common was the clumsy child syndrome, present in 23% of the children. In his study of children and adolescents with epilepsy Brorson[28] found a high rate of CP (20%) and 8% had clumsy gross motor performance and poor coordination. Our series is population based and the results are considered to be truly representative for childhood epilepsy and mental retardation. The prevalence of Ep and MR in combination was 2/1000[7], which is close to the results of Sillanpää *et al*[21] and Sidenvall *et al*[29]. Cerebral palsy was present in 56% of the children with severe MR and in 16% of the children with mild MR, which is a distribution similar to other epidemiological studies[25,30,31]. The 10 cases lost to follow-up had the same proportions of mild and severe MR and CP as the population studied and should thus did not bias the sample.

We wanted to assess different aspects of gross and fine motor development and function such as attainment of motor milestones, static and dynamic body balance, coordination, speed, strength, fine motor precision and velocity, sensation and perception. The assessment of such motor and sensory functions in detail is dependent on the availability of reliable and valid assessment instruments.

There is, however, a lack of appropriate evaluation instruments in the area of motor

performance in children with movement disorders[32]. The Cailler–Azusa scale[9] was developed for multihandicapped children; it is valid and well differentiated at lower levels of motor development, which made it useful for this population. In addition, a new standardized physiotherapy protocol was developed for the heterogeneous population of children with epilepsy[10] including the items above. For the children with CP, the gross motor function measure[11] was found to be a useful tool.

We have tried to distinguish impairment, disability and handicap, as we think that it is important to include and describe these three different concepts from the WHO classification in order to understand better the complexity of the sensorimotor problems of the children.

There was a great difference between children with mild and severe MR regarding their sensorimotor function. In all children, motor developmental level was lower for fine motor skills and visuomotor control than for postural control and locomotion. Skilled fine motor performance with independent finger movements puts great demands on the central nervous system[33], which is probably the reason why children with severe MR and with intractable Ep had a very low developmental level in this area, more than children with mild MR and with controlled Ep.

From the results of the GMFM, it became obvious that the functional level was lowest in children with CP and severe MR. Scolioses and contractures were common, as were severe spasticity. These children were profoundly handicapped in several aspects of life. The correlation between the severity of CP and MR has previously been reported by Aicardi[30], Edebol-Tysk[34], Uvebrant[31] and Corbett[35].

The severity of MR and Ep correlated with the severity of the impairments. The majority of the children with mild impairments came from the mild MR group, and the majority of the children with severe impairments from the severe MR group. Weakness was a common impairment in ambulatory children with mild MR, who were often slow and had a poor movement repertoire and also in hyperactive children. Weakness was most pronounced in children with intractable Ep. In the children with severe MR, major movement disorders with decreased strength were common, more common if their Ep was intractable. Differences in motor behaviour between mild and severe MR were more clearly shown on the disability than on the impairment level.

The severity of epilepsy and the number and severity of additional neurodeficits were reflected in the classification of handicap. There were great differences between mild and severe MR, with a higher degree of handicap in all areas except economic self-sufficiency for the severe MR group. The higher handicap score on orientation reflected a higher frequency of intractable Ep. Children with intractable Ep were also more handicapped in mobility and occupation. Another differing area was social integration, an area Sillanpää pointed out as important in children with Ep[21]. Children with MR and Ep often have immature, slow, poorly developed motor and sensory functions. Parents need support and advice on how to handle their children in everyday life. Physical activity does not increase seizures[36] and the children should be encouraged to be more active. If impairments in gross and fine motor function, coordination, balance and perception are present, the child could be helped by physiotherapy individually or in a group[37], by horse-riding or supervised swimming. A majority of the children with MR and Ep but no CP do not need physiotherapy on a regular basis, but may need to meet a physiotherapist to evaluate their motor development and to give advice on physical training to parents, carers and teachers.

CONCLÜSION

Sensorimotor impairments, resulting in disabilities and handicap, were found to be very common in children with Ep and MR. The severity of the Ep and the MR correlated with the severity of the sensorimotor dysfunctions. In the care of children with Ep and MR, the sensorimotor problems are often forgotten and neglected. To ensure the children proper care and training and to be able to evaluate the effect of training, we have to describe and evaluate their motor capacity and functional abilities in an appropriate way.

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