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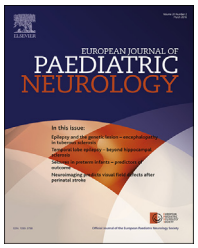

Original article

High prevalence of abnormal motor repertoire at 3 months corrected age in extremely preterm infants

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ABSTRACT

Aims: To compare early motor repertoire between extremely preterm and term-born infants. An association between the motor repertoire and gestational age and birth weight was explored in extremely preterm infants without severe ultrasound abnormalities.
Methods: In a multicentre study, the early motor repertoire of 82 infants born extremely preterm (ELGAN:<28 weeks) and/or with extremely low birth weight (ELBW:<1000 g) and 87 term-born infants were assessed by the "Assessment of Motor Repertoire – 2 to 5 Months" (AMR) which is part of Prechtl's "General Movement Assessment", at 12 weeks post-term age. Fidgety movements were classified as normal if present and abnormal if absent, sporadic or exaggerated. Concurrent motor repertoire was classified as normal if smooth and fluent and abnormal if monotonous, stiff, jerky and/or predominantly fast or slow.
Results: Eight-teen ELBW/ELGAN infants had abnormal fidgety movements (8 absent, 7 sporadic and 3 exaggerated fidgety movements) compared with 2 control infants (OR:12.0; 95%CI:2.7–53.4) and 46 ELBW/ELGAN infants had abnormal concurrent motor repertoire compared with 17 control infants (OR:5.3; 95%CI:2.6–10.5). Almost all detailed aspects of the AMR differed between the groups. Results were the same when three infants with severe ultrasound abnormalities were excluded. In the remaining ELBW/ELGAN infants, there was no association between motor repertoire and gestational age or birth weight.

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Conclusion: ELBW/ELGAN infants had poorer quality of early motor repertoire than term-born infants.The findings were not explained by severe abnormalities on neonatal ultrasound scans and were not correlated to the degree of prematurity. The consequences of these abnormal movement patterns remain to be seen in future follow-up studies.

1. Introduction

Recent advances in perinatal medicine perinatal care have increased survival rates among the most immature infants, but the risk of impaired cognitive and motor outcome remains significant.[1,2] Early prediction of outcome in these infants remains a challenge, and the assessment of general movements developed by Prechtl et al.[3,4] has been shown to be one of the most promising tools to predict cerebral palsy (CP) or normal development in survivors.[3] Abnormal general movements in young infants is also associated with poor cognitive and motor outcome in children born preterm without CP.[5] In order to start early intervention for those with the highest risk of disability, there is a need to develop and improve diagnostic tools.[6]

The General Movements Assessment (GMA) is based on observations of spontaneous movements in normal fetuses,[7] neonates and infants, and has led to a systematic classification defining a set of normal movements for each respective age group.[8] Part of the GMA is the classification of presence or absence of fidgety movements at 9–18 weeks post-term age, which can predict later CP with a high degree of accuracy.[4,9] The "Assessment of Motor Repertoire – 2 to 5 Months" (AMR) is a standardised assessment of general movements,[8,10] also describing the quality and the quantity of the concurrent motor repertoire.[10,11] The concurrent motor repertoire refers to movements which co-occur with fidgety movements and include, among other things: kicking, hand–face contact, hand–hand manipulation, leg lift and fingers fiddling with clothing. The inter-observer reliability of the AMR instrument has been shown to be good.[12]

We have previously shown that an abnormal concurrent motor repertoire, despite present fidgety movements, is associated with an impaired cognitive and motor outcome at 10 years of age in very low birth weight (VLBW) children who did not develop CP.[5] This is in accordance with other studies showing that specific aspects of the concurrent motor repertoire during the fidgety movements period in extremely preterm infants is associated with later adverse motor and cognitive development.[11,13] In addition, as many as half of VLBW children showing the presence of fidgety movements also presented an abnormal concurrent motor repertoire in infancy.[5] However, the distribution of the different items of the AMR in term infants has not been established. In order to improve the diagnostic properties of the AMR for high-risk infants, it is necessary to establish normative data in healthy, term-born infants, and describe possible differences with preterm infants.

The aim of this study was to compare detailed aspects of the early motor repertoire during the fidgety movements' period between extremely preterm infants and healthy, term-born infants. Additionally, we wanted to explore associations between the motor repertoire, gestational age and birth weight in extremely preterm infants without severe abnormalities on neonatal imaging.

2. Material and methods

2.1. Design

The present study was a prospective multicentre cohort study including infants born between Jan. 1st, 2009 and Dec. 31st 2013 at Trondheim University Hospital (hospital 1), and between Jan. 1st, 2009 and Dec. 31st, 2012 at Oslo University Hospital (hospital 2) and at University Hospital of North Norway (hospital 3) in Norway. Inclusion criteria were extremely premature born infants with gestational age <28 weeks (ELGAN) and/or a birth weight <1000 g (ELBW) who had their follow-up at one of the participating university hospitals or a collaborating local hospital. The infants were invited to participate before discharge from their respective Neonatal Intensive Care Units (NICU). All parents that were asked for participation gave their written consent. Infants with syndromes, malformations, major surgery or with other problems which could affect spontaneous movements were excluded from the study. Infants participating in early intervention studies aimed to influence motor and/or cognitive development could not be included in this study.

Table 1 – Clinical characteristics of the study population.

	ELBW/ELGAN (n = 82)		Control (n = 87)	
	Mean	**(SD)**	**Mean**	**(SD)**
Gestational age (weeks)	26.6	(1.8)	39.6	(1.0)
Birth weight (g)	884	(217)	3689	(400.8)
	n	**(%)**	**n**	**(%)**
Boys	47	(58)	45	(52)
Birthweight ≤10th percentile	22	(33)	4	(5)
Intraventricular hemorrhage grade 1	17	(21)	0	(0)
Intraventricular hemorrhage grade 2	4	(5)	0	(0)
Intraventricular hemorrhage grade ≥ 3[a]	3	(4)	0	(0)
Periventricular leukomalacia grade 1	1	(1)	0	(0)
Bronchopulmonal dysplasia	14	(17)	0	(0)
Treated retinopathy of prematurity	4	(5)	0	(0)

SD = Standard deviation.
ELBW = Extremely low birth weight; <1000 g.
ELGAN = Extremely low gestational age newborn; <28 week.
[a] One infant had intraventricular hemorrhage grade 3 and a cystic periventricular leukomalacia.

Table 2 – Results of the assessment of early motor development in the ELBW/ELGAN group and the control group.

Motor optimality list	Score	ELBW/ ELGAN n = 82		Control n = 87		P value
		n	(%)	n	(%)	
1. Fidgety movements	12 = normal	64	(78)	85	(98)	<0.001
	4 = abnormal (exaggerated)	3	(4)	0	(0)	
	1 = absent or sporadic	15	(19)	2	(2)	
Temporal organisation of fidgety movements	F++	4	(5)	22	(25)	<0.001
	F+	63	(77)	63	(72)	
	F+/–	7	(9)	2	(2)	
	F–	8	(10)	0	(0)	
2. Repertoire of co-existent other movements	4 = age–adequate	73	(89)	87	(100)	0.006
	2 = reduced (5 or 6 movement patterns)	3	(4)	0	(0)	
	1 = absent (less than 5)	6	(7)	0	(0)	
3. Presence and normality of individual movement patterns	4 = N > A	79	(96)	87	(100)	0.198
	2 = N = A	1	(1)	0	(0)	
	1 = N < A	2	(2)	0	(0)	
4. Presence and normality of individual postural patterns	4 = N > A	68	(83)	82	(94)	0.039
	2 = N = A	7	(9)	4	(5)	
	1 = N < A	7	(9)	1	(1)	
5. Quality of the concurrent motor repertoire	4 = smooth and fluent	36	(44)	70	(81)	<0.001
	2 = abnormal, not cramped–synchronized	46	(56)	17	(20)	
	1 = cramped–synchronized	0	(0)	0	(0)	

Motor optimality score	Median	IQR	Median	IQR	0.001
	26	(23–28)	28	(28-28)	
	n	(%)	n	(%)	
Detailed aspects of motor repertoire					
Hand–hand contact	23	(28)	37	(43)	0.049
Foot–foot contact	56	(69)	75	(86)	0.016
Hand–hand manipulation	14	(17)	33	(38)	0.002
Foot–foot manipulation	31	(38)	51	(59)	0.007
Fiddling	22	(27)	43	(49)	0.003
Leg lifts, flexion at knees	70	(85)	85	(98)	0.013
Leg lifts, extension at knees	46	(56)	52	(60)	0.194
Movement character					
Smooth and fluent	36	(44)	70	(81)	<0.001
Jerky	4	(5)	3	(3)	0.641
Monotonous	41	(50)	13	(15)	<0.001
Tremulous	1	(1)	0	(0)	0.302
Stiff	7	(9)	0	(0)	0.005
Cramped	0	(0)	0	(0)	–
Synchronuous	0	(0)	0	(0)	–
Cramped-synchronised	0	(0)	0	(0)	–
Predominantly slow speed	1	(1)	0	(0)	0.302
Predominantly fast speed	10	(12)	2	(2)	0.012
Predominantly large amplitude	5	(6)	0	(0)	0.019
Predominantly small amplitude	0	(0)	0	(0)	–
Postures					
Variable finger postures	46	(56)	61	(70)	0.059
Few finger postures	36	(44)	23	(26)	0.017
Predominant fisting	17	(21)	9	(10)	0.061
Finger spreading	1	(1)	1	(2)	0.966

Chi-square test.
IQR = Interquartil range.
ELBW = Extremely low birth weight.
ELGAN = Extremely low gestational age newborn.
N = Normal.
A = Abnormal.
F++ = Fidgety movements continual.
F+ = Fidgety movements intermittent.
F+/– = Fidgety movements sporadic.
F– = Fidgety movements absent.

A control group of healthy singleton, full-term infants with normal birth weight was recruited from local health centres and the maternity ward between 2010 and 2014. Only mothers with an uncomplicated pregnancy and delivery and infants with an uncomplicated neonatal period were invited to participate in the control group.

2.2. Clinical data

Gestational age was based on the second trimester routine ultrasound assessment. For ELBW/ELGAN infants, information on birth weight, sex and cerebral ultrasound (US) abnormalities was collected from the Norwegian Neonatal Network's registry, in which data from the NICUs is registered prospectively on a daily basis. Cerebral MRI of preterm infants was not routine practice in any of the participating units. Cerebral US was done according to each unit's routine practice, but included at least one examination during the first, and second week in addition to a later scan during week 3, 4 and/or before discharge.

2.3. Video recordings and the "Assessment of Motor Repertoire – 2 to 5 months"

All videos were recorded in compliance with a procedure described by Einspieler et al.[8] Infants were fully awake without crying or fussing and were lying supine on a mattress at a standardised distance (1.62 m) from the video camera. If multiple recordings of the same infant had been performed, the video closest to 12 weeks post-term age was used for the assessment and analysis.[8] Assessments of the video-recordings were carried out by two GMA certified and experienced paediatric physiotherapists blinded to the infants' clinical histories. First the FMs were assessed independently by each observer. The concurrent motor repertoire was then assessed by the same observers by replaying the videos. In cases of disagreements, a consensus was reached, based on additional evaluations.

According to Bruggink et al.,[10] the AMR is based on the scoring of five subcategories (Table 2). The first three subcategories are "Fidgety movements" (max. 12 points), "Repertoire of co-existent other movements" (max. 4 points), and "Presence and normality of individual movement patterns" (max. 4 points). The fourth subcategory, "Presence and normality of individual postural patterns" (max. 4 points) is based on the observation of items in the section "Postural pattern". The fifth subcategory is "Quality of the concurrent motor repertoire"[11] or "Quality of concurrent movements"[13] (also reported as "Movement character"[8]), which classifies the overall movement character as smooth and fluent (4 points); abnormal, but not cramped-synchronised (2 points) or abnormal and cramped-synchronised (1 point). Finally, the sum of scores from five subcategories results in a total of 5–28 points, the Motor Optimality Score (MOS).

Fidgety movements, if present, are interspersed with pauses. According to the duration of these pauses, the temporal organisation of fidgety movements can be classified as continual (F++), intermittent (F+) or sporadic (F+/–).[8] Continual and intermittent fidgety movements are given 12 points, exaggerated movements are given 4 points, and sporadic or absent fidgety movements are given 1 point in the AMR subcategory "Fidgety movements". In this study, fidgety movements (FMs) were classified as normal if continual or intermittent, and as abnormal if exaggerated, sporadic or absent. Two items of the original AMR were taken out in the present study: "Saccadic arm movements", because these can easily be confused with exaggerated fidgety movements; and abnormal "Mouth movements" because these co-occur with abnormal "Tongue movements". "Hand–face contact" and "Hand–mouth contact" were regarded as one item. The same modifications were used in a previous MOS study.[12]

2.4. Statistical analyses

Data was analysed using SPSS Statistic, version 21 (IBM SPSS Statistic, Chicago, IL, USA). Differences in motor repertoire items between groups were analysed using the chi-square test, and differences in non-parametric data were analysed by means of the Mann–Whitney U test. An odds ratio of 95% CI was calculated as an estimate of the risk of having abnormal general movements in the ELBW/ELGAN group as compared to the control group. Correlation coefficients between motor repertoire subcategories and gestational age and birth weight were calculated using Spearman's rho.

2.5. Ethics

The study was approved by The Regional Ethics Committee (project number: 2011/1811). All parents gave their written informed consent.

3. Results

3.1. Demographic and clinical characteristics

The primary study cohort included 87 ELBW/ELGAN infants born from 2009 to 2013. Of 87 ELBW/ELGAN infants born at hospital 1, 57 (66%) infants were invited to participate and consented, the rest were followed up at local hospitals. Of the 57 infants included in the study, 4 infants were excluded; one infant because of a plexus brachialis injury and the video recordings of 3 infants were not assessable because the infants were crying. At hospital 2, 25 (18%) of a total of 135 patients consented to participate; a majority of patients were not included because they had follow-up at other hospitals. One infant was excluded because of blindness. At hospital 3, 5 (13%) of a total of 40 ELBW/ELGAN infants were included because the majority of these infants participated in an early intervention study. Thus, a total of 82 ELBW/ELGAN infants (35 girls and 47 boys) were assessed with the GMA and AMR at mean 12.3 weeks post term age.

Ninety-six healthy term-born infants were invited to participate in the study. Two infants did not show up for the appointment, five appointments were cancelled because the infant was ill, and two video-recordings could not be assessed because the infant was in the wrong state for assessment. Thus, 87 infants (42 girls and 45 boys) were included.

Infants in the ELBW/ELGAN group had a mean birth weight of 884 (SD 217) grams and a mean gestational age of 26.6 (SD 1.8) weeks, compared with 3689 (SD 401) grams and 39.6 (SD

1.0) weeks, in the control group, respectively. Seven-teen ELBW/ELGAN infants (21%) had intraventricular haemorrhage (IVH) grade 1, 4 infants (5%) had grade 2, 2 infants (3%) had grade 3 and 1 (1%) infant IVH grade 4. One of the infants with IVH grade 3 also developed cystic periventricular leukomalacia (Table 1).

3.2. *Motor repertoire at 3 months post-term age*

The infants' motor repertoire were video-recorded at mean 12.3 (SD1.1) weeks post-term age in the ELBW/ELGAN group and mean 12.2 (SD 1.8) weeks post-term age in the control group. The mean length of the video recordings was 4.2 min (SD1.0) in the ELBW/ELGAN group and 4.5 min (SD1.0) in the control group. Each video recording was assessed by the observers 2.1 (SD 0.8) times.

Table 2 shows the result of the assessment of early motor repertoire in the ELBW/ELGAN and the control groups at 12 weeks post-term age. A higher proportion of infants in the ELBW/ELGAN group had absent (n = 8), sporadic (n = 7) or exaggerated (n = 3) FMs compared to the control group ($p < 0.001$). Continual FMs were seen in 4 (5%) ELBW/ELGAN infants in contrast to 22 (25%) controls ($p < 0.001$). Almost all detailed aspects of the motor repertoire described in Table 2 differed significantly between the groups. Hand–hand manipulation was twice as frequent in the control group as in the ELBW/ELGAN group (33 [38%] versus 14 [17%]; $p = 0.002$), and foot–foot manipulation was seen in 51 (59%) infants in the control group as opposed to 31 (38%) in the ELBW/ELGAN group ($p < 0.007$). The quality of the concurrent movements was assessed as smooth and fluent twice as often in the control group as in the ELBW/ELGAN group (70 [81%] versus 36 [44%]; $p < 0.001$). Median MOS was 26 points (interquartile range 23–28) in the ELBW/ELGAN group and 28 points (interquartile range 28–28) in the control group ($p = 0.001$) (Table 2). There were no significant differences in the third subcategory, "Presence and normality of individual movement patterns".

The odds of having abnormal, absent or sporadic fidgety movements in the ELBW/ELGAN group were 12.0 (95% CI: 2.7–53.4) (Table 3) compared to the control group. Forty-six (56%) ELBW/ELGAN infants had an abnormal quality of the concurrent motor repertoire compared to 17 (20%) control infants (OR: 5.3; 95% CI: 2.6–10.5). The odds of having an abnormal concurrent motor repertoire despite the presence of FMs were 4.1 (95% CI: 2.0–8.7) (Table 3).

When 3 infants with severe ultrasound abnormalities (IVH grade 3–4 and/or PVL) were excluded from the ELBW/ELGAN group, differences in AMR remained significant between the groups. There was no significant correlations between motor repertoire and gestational age ($r_s = -0.11$ to 0.16, $p = 0.17–0.97$) or birth weight ($r_s = -0.20$ to 0.09, $p = 0.09–0.99$) within the ELBW/ELGAN group, both with and without infants with severe IVH and PVL.

Table 3 – Odds ratio (OR) with 95% confidence intervals (95% CI) as an estimate of the relative risk of having abnormal fidgety movements, abnormal quality of the concurrent motor repertoire and presence of fidgety movements and abnormal concurrent movements in the ELBW/ELGAN group compared with the control group.

	Abnormal n (%)	Normal n (%)	OR	(95% CI)
Quality of fidgety movements				
ELBW/ELGAN	18 (22)	64 (78)	12.0	(2.7–53.4)
Control	2 (2)	85 (98)	1.0	
Quality of the concurrent motor repertoire				
ELBW/ELGAN	46 (56)	36 (44)	5.3	(2.6–10.5)
Control	17 (20)	70 (81)	1.0	
Combination of fidgety movements and concurrent motor repertoire				
ELBW/ELGAN	30 (47)	34 (53)	4.1	(2.0–8.7)
Control	15 (18)	70 (82)	1.0	

ELBW = Extremely low birth weight.
ELGAN = Extremely low gestational age newborn.

4. Discussion

In this study, we found significant differences in almost all subcategories of the early motor repertoire between ELBW/ELGAN infants and a control group of healthy term-born infants. The odds of having abnormal quality of the concurrent movement repertoire along with normal fidgety movements were four times higher in the ELBW/ELGAN group compared to controls. These findings were not influenced by the exclusion of infants with severe abnormalities on neonatal cerebral ultrasound, and no associations between early motor repertoire and gestational age or birth weight were found within the group of preterm infants.

A limitation of the current study is that it was not population-based and only a proportion of all ELBW/ELGAN infants born at the 3 participating hospitals during the study period were included. Non-inclusion was mainly due to participation in other studies or follow-up taking place at other hospitals without selection based on the infants' medical history. Thus, the results are likely to be valid for other similar populations as well.

This is the first study to compare several aspects of the motor repertoire between a well-characterised group of ELBW/ELGAN and term-born infants. Two experienced observers conducted the video recording and analyses of the motor repertoire without knowledge of the infants' medical history and on video recordings with a standardised set-up. "Assessment of Motor Repertoire – 2 to 5 Months" has proven to be a valuable tool for systematically describing general movements and its association with the long-term neurological outcome.[10]

However, the motor optimality score used in "Assessment of Motor Repertoire – 2 to 5 Months" has some limitations. In this study, however statistically significant, the apparently minor difference in MOS of two points between the groups illustrates that this score depends very much on the score given for FMs, which alone accounts for 12 out of a total of 28 points. Clinically important characteristics like the quality of the concurrent motor repertoire account for a maximum of 4 points.[14] Each of the five subcategories should be analysed and interpreted individually, as has been done in this study.

We found that all but one of the subcategories of "Assessment of Motor Repertoire – 2 to 5 Months" differed between the two groups. An interesting finding is that 10% of the infants in the ELBW/ELGAN group had an absence of FMs. Whether this reflects a 10% prevalence of CP in the extremely preterm population[15] remains to be verified in follow-up studies. A new finding is that continual FMs were rarely seen in the preterm group, while intermittent FMs were equally frequent in the two groups. The significance of the temporal organisation of FMs is unclear except for the well-established relationship between absence of FMs and CP.[3] A recent study of 29 infants born preterm showed that 21 infants were scored as having continual FMs, six infants showed sporadic FMs, and two infants were scored as having no FMs. However, this study does not distinguish between continual and intermittent FMs.[16] According to Einspieler et al.,[8] the temporal organisation of FMs varies with age in the fidgety period. It could therefore be that the rare occurrence of continual FMs in the extremely preterm group compared with term infants may reflects delayed maturation in this group. The question as to whether these findings influence the outcome should continue to be examined.

The only subcategory with similar results for extremely preterm and control infants was "Presence and normality of individual movement patterns". This means that the preterm infants expressed the same number of normal (or abnormal) movement patterns as the infants in the control group. This is one of two categories describing the quantity of concurrent movements. Even though the other quantitative category "Presence and normality of individual postural patterns" differed between the groups, one may speculate that preterm birth affects the quality more than the quantity of movements.

Few studies have published results on the quality of the motor repertoire in healthy term-born infants. Recently, Hitzert et al.[17] found that as many as 58% of term-born infants showed an abnormal quality of concurrent movements. This stands in contrast to our study, where 20% of the control infants had an abnormal quality of concurrent movements, even though both studies show that abnormal quality of early motor repertoire is frequent in a healthy population of term-born infants. The AMR classifies early motor repertoire as normal versus abnormal. However, given the high prevalence of so-called abnormal movements in healthy infants, it may be more pertinent to use the terms "optimal" and "suboptimal" movements.[18] Nevertheless, Hitzert et al.[17] reported that an abnormal quality of the concurrent motor repertoire was associated with behaviour problems in early school age. Whether our findings of abnormal movements in 20% of the control group have the same implications is a subject for future studies.

IVH and PVL are independent risk factors for adverse outcome in preterm infants.[19,20] However, in our study, only 3 of 82 infants had IVH grade 3–4 and/or PVL, and the presence of these brain abnormalities did not explain the difference between the preterm group and controls with respect to early motor repertoire. The reason for this may be that severe cerebral ultrasound abnormalities mainly indicate CP, whereas the motor repertoire is a general expression of early motor development and associate not only with CP but also with the cognitive and behavioural outcomes.[13] In addition, few infants had severe ultrasound abnormalities in the present study.

Furthermore, we found no correlation between AMR and gestational age or birth weight. This finding may be due to the relatively small range of gestational ages with only the most immature infants included. If AMR predicts cognitive and/or motor outcomes, this finding is not in accordance with findings of increasing risk of adverse outcomes with decreased gestational age.[19] As the incidence of severe IVH and PVL decreases, the need for early and accurate tools to identify those with the highest risk of adverse outcomes is even more important. Based on this and previous studies[5,11,13] it is likely that AMR could be sensitive enough for that purpose. It is of great importance to have appropriate methods to reveal neurodevelopmental problems to be able to start intervention as early as possible. Recent research indicates that early intervention can help the brain to reorganize aberrant signal patterns[21–23] and increased awareness and support from family, society and school is probably helpful.[24]

The quality of general movements could reflect brain function.[25] In fetal life, cortical subplate neurons are important in establishing the correct wiring and functional maturation of the cerebral cortex.[4,26] As Volpe[26] suggests, periventricular white matter injury would affect both white matter axons and their originating neurons in the cerebral cortex and thalamus, as well as the developing cerebral cortical neurons. Thus, damage to the white motor tracts is likely to be expressed as poor quality of motor behaviour. Consequently, an abnormal motor repertoire in early postnatal life may reflect an impairment of normal brain development and could possibly explain the later appearance of both motor and cognitive problems.[5,13,27,28] A monotonous, stiff or jerky movement character can also be a consequence of impaired postural control; as previously described in preterm infants, these show less mobile postural behaviour than term-born infants.[29] However, an abnormal motor repertoire can also result from an infant's reduced ability to interact with the environment and influence the further development of appropriate motor skills. This could at least partly explain the aforementioned association between the quality of general movements and later motor and cognitive outcome.[28]

5. Conclusions

We found poorer quality of the early motor repertoire in a group of ELBW/ELGAN infants compared with a control group of term-born infants at 12 weeks corrected age. Infants born extremely preterm had a risk of abnormal concurrent motor repertoire that was 4 times higher than controls, despite the presence of fidgety movements. The findings could not be explained by severe US abnormalities, as this was found in only three infants. Furthermore, findings were not correlated to the degree of prematurity within this ELBW/ELGAN group. The consequences of these abnormal movement patterns remain to be seen in future follow-up studies.

Conflict of interest

None declared.

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