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Is There a Relationship Between Fidgety Movements and a History of Intrauterine Growth Restriction in Preterm Infants?

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ABSTRACT

Background: Preterm infants with a history of intrauterine growth restriction (IUGR) are more susceptible to neurodevelopmental disorders, even in the absence of brain damage. Several diagnostic tools exist for the functional assessment of the young nervous system. Assessment of general movements (GMs) is one method that predicts adverse neurodevelopmental outcomes in at-risk infants. In this study, we assessed fidgety movements (FMs), a subtype of GMs, in preterm infants with and without a history of IUGR. Our objective was to determine if there was a correlation between absent or abnormal FMs and a history of IUGR in preterm infants. We also examined this correlation using the Ages and Stages Questionnaire (ASQ).
Methods: A case-control study was conducted on preterm infants. The presence or absence of IUGR was confirmed by antenatal Color Doppler examination. Infants were referred to the Neurodevelopment Clinic at a corrected age of 3-5 months. Demographic, clinical, and maternal information was recorded. All infants' FMs were recorded, observed, and interpreted by a trained pediatrician. The ASQ was completed by parents.
Results: Thirty preterm infants were included. The mean gestational age at birth was 33 weeks, and the mean corrected gestational age at the time of the study was 14 weeks. No significant relationship was found between absent/abnormal FMs and a history of IUGR (P = 0.634). Significant associations were observed between absent/abnormal FMs and prolonged NICU admission (p = 0.004), surfactant requirement (p = 0.045), and maternal gestational diabetes mellitus (p = 0.046). There were also significant relationships between FMs and the ASQ in the communication (P = 0.014), gross motor (P = 0.0001), fine motor (P = 0.037), social (P = 0.037), and problem-solving (P = 0.001) domains.
Conclusion: The present study showed that there was no relationship between absent or abnormal FMs and IUGR in preterm infants.

Keywords: Fidgety movements, General movement, Infant, Intrauterine growth restriction, Premature

Introduction

Preterm neonates are susceptible to neurological disorders even in the absence of brain damage (1). Intrauterine growth restriction (IUGR), defined as specific fetal biometric measures <10th percentile for a particular gestational age, is another cause of deleterious consequences in the nervous system, resulting in adverse neurodevelopmental outcomes (2, 3). The manifestations of these perinatal complications may extend to later life and childhood (4).

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Several methods exist to evaluate brain damage and predict adverse neurodevelopmental status in at-risk infants (5-7). Prechtl's method, which assesses the quality of general movements (GMs), is a promising method for predicting possible neurological complications (8, 9). General movements are categorized into 3 groups based on postnatal periods: Preterm (GMs before 36-38 weeks), Writhing (GMs from birth to 6-8 weeks), and fidgety movements (FMs) from 6-8 to 15-20 weeks (10). The absence of fidgety movements has a high predictive value for brain damage, with a sensitivity of more than 98% and a specificity of more than 91% (11). This non-invasive and cost-effective technique is a valid and reliable tool for early functional assessment of the young nervous system (1). Its predictive value is similar to EEG and neuroimaging methods and higher than other neurological examinations (12).

Previous studies have shown correlations between the absence of FMs and cerebral palsy (8, 13). It has also been demonstrated that the absence of FMs is significantly correlated with lower gross motor scores and total motor quotient in one-year-old infants with a history of very low birth weight (14).

Diagnosing developmental disorders early in life is critical but challenging in many countries with limited human and financial resources. On the other hand, there is increasing evidence emphasizing the importance of early interventions during the first months of life to improve neurodevelopmental outcomes in at-risk infants (1, 15, 16). To our knowledge, very few studies from developing countries report the relationship between an infant's GMs and a history of IUGR (14). Hence, we conducted the present study to assess the correlation between the types of FMs in preterm infants with and without IUGR. We also examined this correlation using the Ages and Stages Questionnaire (ASQ).

Methods

A case-control study was conducted at Vali-E-Asr Hospital, affiliated with Tehran University of Medical Sciences (2018-2019). The study population consisted of infants with a corrected gestational age of 2-5 months, born between 32-36 weeks of gestation. All participants were assigned to either the case or control group. The case group included infants with a history of IUGR, while the control group consisted of preterm-born infants without such a history. The presence or absence of IUGR (defined as specific fetal biometric measures <10th percentile for a particular gestational age) (17) was confirmed by antenatal Color Doppler examination. Both groups were matched for age and gestational age. Exclusion criteria included a history of IVH with grades >1, 1st and 5th minute Apgar scores below 6, the requirement of mechanical ventilation, and congenital or chromosomal anomalies.

Both groups, as at-risk neonates, received a series of timely and regular visits at the neurodevelopment follow-up clinic. To assess developmental domains, the ASQ (7) questionnaire was completed for all participants by their parents. The ASQ is composed of six questions for each domain: fine motor, gross motor, communication, problem-solving, and social skills. Total ASQ scores (yes=10, sometimes=5, and not yet=0) were calculated for every infant and recorded in a checklist. Considering the cut-off point for each domain (age-specific norms of <2 standard deviations), the final results were classified as either normal or abnormal (18-20).

Subsequently, infants' FMs were assessed based on Prechtl's method (21, 22). Before videotaping, the infant (wearing only a diaper) was placed supine to allow for easy movement of their limbs in all directions. All infants' GMs were recorded by a camera for 5-10 minutes. The interval between the infant's feedings and movement evaluation was at least 30 minutes. Finally, the recorded videos were observed and interpreted by a trained pediatrician who was unaware of the grouping system. Movements during crying, hiccups, or pacifier sucking were excluded from interpretation (22). The final results were categorized into two main groups: normal and absent/abnormal FMs (10, 23).

Our objective was to determine any correlation between FMs and a history of IUGR among preterm infants. The relationships between demographic variables, ASQ scores, and infants' GMs were also assessed.

The calculated sample size was 15 in each group (10), considering a study power of 80%, an effect size of 10%, and an alpha error of 0.05. Data related to demographic and clinical characteristics, as well as video-recorded information, were analyzed using SPSS software version 21.

The results of the Kolmogorov-Smirnov and Shapiro-Wilk tests indicated that the variables were not normally distributed. For comparing variables, the Chi-Square and Fisher's Exact Test (for qualitative variables) as well as the Kruskal-

Wallis test (for quantitative variables) were used. P-values <0.05 were considered statistically significant.

Ethical Approval

This investigation was derived from a medical specialty thesis. Ethics approval for the study was obtained from the institutional review board of Tehran University of Medical Sciences according to the Declaration of Helsinki (IR.TUMS.IKHC.REC. 1398.010).

The study was explained to the parents of participants, and then they were asked to sign an informed written consent form. Gathered data and the results related to infants' fidgety movements or ASQ scores were considered confidential except for their parents.

Results

Thirty infants (14 females and 16 males) from the case and control groups entered the study. The means of gestational and corrected age were 33.16±0.87 weeks (Min: 32, Max: 35) and 14.7±3.9 weeks, respectively. The means of mothers' and fathers' age were 29.43±4.53 and 33.80±5.749 years, respectively. Data related to demographic and clinical characteristics are shown in Table 1. More than 60% of parents had a lower diploma, and 13.3% of mothers were employed. Hypothyroidism and hypertension (HTN) were the most common perinatal complications. The first- and fifth-minute Apgar scores among all neonates were above seven, and the means of birth weight and head circumference were 1808.6±308 g and 31.13±1.30 cm, respectively. Fifty percent of all participating infants had normal FMs, and 50% had abnormal/absent FMs (23.3% abnormal, and 26.7% absent).

Comparing variables between the two groups, the results indicated that birth weight (P=0.001), birth head circumference (P=0.048), and surfactant requirement (P=0.03) in the case group were significantly lower than in the control group. The history of maternal diabetes (pre/gestational diabetes) in the control group was significantly more frequent compared to the case group (P=0.042). No significant differences were observed between the groups considering infants' gestational age, corrected age, weight, duration of NICU admission, frequency of neonatal icterus, IVH> grade 1, using nasal CPAP, causes of preterm delivery, maternal HTN, or hypothyroidism (P>0.05). There was no significant difference between the case and control groups regarding the results of the FM assessment (P=0.634). Detailed data are shown in Table 2.

The status of FMs was significantly correlated with a history of surfactant requirement. FMs in 4 infants with surfactant injection were normal, and in 8 were disturbed, while more infants (11

Table 1. Parents' demographic characteristics

Variables	Level	Frequency (N)	Percent (%)
Mother's education	≤ High school	19	63.3
	> High school	11	36.7
Father's education	≤ High school	20	66.7
	> High school	10	33.3
Mother's occupation	Unemployed	26	86.7
	Employed	4	13.3
Father's occupation	Unemployed	8	26.7
	Employed	22	73.3
GDM*	No	25	83.3
	Yes	5	16.7
HTN**	No	21	70.0
	Yes	9	30.0
Preeclampsia	No	24	80.0
	Yes	6	20.0
Hypothyroidism	No	18	60.0
	Yes	12	40.0

*GDM: Gestational Diabetes Mellitus,
**HTN: Hypertension

Table 2. Maternal and infantile characteristics

Characteristics	IUGR group	Non-IUGR group	P value
Maternal complication during pregnancy (N)			
GDM[a]	-	5	0.042
HTN[b]	7	2	0.109
Hypothyroidism	7	5	0.456
Gestational age (weeks; Mean±SD)	32.20±0.8	33.1±0.9	0.839
Corrected age (weeks; Mean±SD)	14.70±3.9	15.20±2.8	0.676
Birth weight (gram; Mean±SD)	1630±240	1980±270	0.001
Weight at time of study (gram; Mean±SD)	5650±810	5766±686	0.589
Birth head circumference(Cm; Mean±SD)	30.6±1.2	31.6±1.2	0.048
NICU admission (days; Mean±SD)	16.69±1.2	16±6	0.976
Icter (n)	7	10	0.269
Nasal CPAP (n)	12	13	0.624
surfactant requirement (n)	2	10	0.003
IVH≥ grade 1 (n)	8	10	0.456
Cause of preterm delivery (n)			
Placental accidents	8	6	
PROM	1	5	0.06
Preeclampsia	5	1	
Preterm labor	1	3	
Types of Fidgety movements (n %)			
Normal	9 (60)	6 (40)	
Absent	3 (20)	5(33.4)	0.634
Abnormal	3(20)	4 (26.6)	

[a]GDM: Gestational Diabetes Mellitus
[b]HTN: Hypertension

Table 3. Relationships between Fidgety movement and participants' characteristics

Characteristics	Levels	Fidgety movements(N)			P value*
		Normal	absence/abnormal		
			Absent	Abnormal	
Sex	Female	7	4	3	0.832
	Male	8	4	4	
Maternal GDM[a]	No	14	5	6	0.046*
	Yes	1	3	1	
Maternal HTN[b]	No	11	6	4	0.693
	Yes	4	2	3	
Maternal Hypothyroidism	No	10	3	5	0.277
	Yes	5	5	2	
Icter	No	8	3	2	0.474
	Yes	7	5	5	
Surfactant requirement	No	11	2	5	0.045*
	Yes	4	6	2	
Nasal CPAP	No	3	1	1	0.928
	Yes	12	7	6	
IVH	No	6	4	2	0.579
	Yes	9	4	5	

[a]GDM: Gastational Diabetes Mellitus,
[b]HTN: Hypertension
*Chi-square test

subjects) without such a history showed normal FMs (P=0.045). Maternal GDM was also another significant risk factor for disturbed FMs (P=0.046). On the other hand, no relationships were observed between FMs and neonates' sex, the history of icterus, IVH, Nasal CPAP, parents'

Table 4. Relationships between Fidgety movement and participants' quantitative characteristics

Character	Fidgetymovement		N	Mean ±Std	P value*
Birth Weight (g)	Normal		15	1768.67±315.81	0.671
	Absence/Abnormal	Absent	8	1900±344.09	
		Abnormal	7	1790±269.01	
Birth Head Circumference (cm)	Normal		15	30.60±1.18	0.106
	Absence/Abnormal	Absent	8	31.75±1.28	
		Abnormal	7	31.57±1.27	
Days of NICU Admission	Normal		15	13.66±5.19	0.004*
	Absence/Abnormal	Absent	8	21.25±6.69	
		Abnormal	7	18.00±5.47	

*Kruskal Wallis test

educational level, maternal complications such as HTN, and hypothyroidism (P>0.05) (Table 3).

Also, the results showed significant associations between FMs and the duration of NICU admission (P=0.004). The NICU admission period among infants with disturbed FMs was significantly more extended than in infants with normal FMs (Table 4).

According to the results, a history of IUGR was not a significant factor influencing ASQ scores (P>0.05) (Table 5). Nonetheless, associations between FMs and ASQ in several developmental domains were notably significant. None of the infants with abnormal communication skills showed normal fidgety movements. The frequency of absent FMs was also higher than abnormal FMs among these subjects (P=0.014). Infants with abnormal gross motor (P=0.0001), fine motor (P=0.037), social (P=0.037), or problem-solving (P=0.0001) skills did not have normal fidgety movements (Table 6).

Table 5. Relationships between Ages and Stages Questionnairein two groups

ASQ Developmental Domain		IUGR[a]	Non-IUGR	P value*
Communication	Normal	11	14	0.330
	Abnormal	4	1	
Gross motor	Normal	9	10	0.500
	Abnormal	6	5	
Fine motor	Normal	13	13	0.701
	Abnormal	2	2	
Problem solving	Normal	11	11	0.559
	Abnormal	4	4	
Personal- Social	Normal	12	14	0.598
	Abnormal	3	1	

[a] Intrauterine growth restriction
*Fisher Exact Test

Table 6. Relationships between Ages and stages Questionnaire and Fidgety movement

ASQ Developmental Domain		Fidgety Movement			P value*
		Normal (n)	absence/abnormal		
			Absent (n)	Abnormal (n)	
Communication	Normal	15	4	6	* 0.014
	Abnormal	0	4	1	
Gross motor	Normal	15	1	3	* 0.0001
	Abnormal	0	7	4	
Fine motor	Normal	15	6	5	*0.037
	Abnormal	0	2	2	
Problem-solving	Normal	15	1	6	* 0.0001
	Abnormal	0	7	1	
Social	Normal	15	6	5	*0.037
	Abnormal	0	2	2	

*Fisher Exact Test

Discussion

In 1997, Prechtl showed that general movements' assessment is an excellent predictive technique that could distinguish infants at risk of neurological complications (8). Later studies confirmed this relationship between abnormal general movements and adverse neurodevelopmental outcomes among infants with perinatal risks like preterm birth or cerebral palsy (13, 24, 25, 26); however, this correlation among IUGR infants needs more investigation. Therefore, the present study compared the types of FMs in preterm infants with and without a history of IUGR.

According to the results, no significant difference was observed between the IUGR and the Non-IUGR-born infants regarding the absence/abnormal FMs. We also found that a history of IUGR was not a significant factor influencing ASQ scores. This means that a history of IUGR was not a responsible factor for absence/abnormal FMs or abnormal ASQ at ages 2 to 5 months. Very few studies have focused on the status of GMs in infants born with IUGR. In accordance with our finding, Bos et al. indicated an unclear correlation between neurodevelopmental delay and qualitative movement patterns in 0-40 weeks-aged infants with a history of IUGR (13). Einspieler et al. also showed less predictive value of absence/abnormal FMs in uncomplicated IUGR conditions with mild neurological consequences (21). On the contrary, Zuk et al. showed that abnormalities in early (9-11 weeks) and late (14-16 weeks) FMs were statistically more frequent among the IUGR group in comparison with the controls (10). According to Zuk et al., eleven IUGR cases showed abnormal GMs, and neurodevelopmental scores among two-year-old IUGR infants were statistically correlated with GMs (10). The significant predictive value of GMs in identifying hemiplegia among infants with cerebral infarction has also been reported (22). Inconsistent with our finding, Sacchi et al. also showed that the toddlers who were born IUGR and very preterm had lower neurodevelopmental scores associated with cognitive and motor domains in comparison with their control counterparts (27). It seems that the diversity between the results may correlate to the age of participants in assessing neurodevelopmental outcomes, sample size, duration of the follow-up period, severity of neurological complications, types of brain lesions, or levels of infarction.

Assessing relationships between FMs and neonatal or parental quantitative factors, our results showed significant associations between absence/abnormal FMs with prolonged NICU admission, more surfactant requirement, and maternal GDM. These factors may show the severity of hypoxic-ischemic neurological, metabolic, or respiratory complications affecting an infant's fidgety movements (28). Another study by Porro et al. indicated that the number of hospitalization days was a significant factor ($P<0.001$) for poor GMs in 3-month-aged infants with a history of very low birth weight (29). Maternal GDM was also pointed to as a risk factor for developmental problems and disturbed general movement; gestational diabetes influences the fetal autonomous system, particularly vagal tone (30, 31).

Abnormal GMs during early life may distinguish infants in need of early psychomotor interventions and close follow-up. Beccaria et al. demonstrated a significant correlation between poor general movements and low neurodevelopmental quotient in very preterm infants aged two years. Using the Griffiths scale, the authors assessed neurodevelopmental status, including developmental quotient, in addition to five domains of functioning such as locomotor, personal/social, hearing/speech, eye/hand coordination, and performance. It was indicated that infants with poor repertoire GMs during the writhing period had a lower neurodevelopmental quotient at two years, as well as lower scores in hearing/speech, eye/hand coordination, and performance (23). Olsen et al. showed that abnormality in GMs at ages <36 weeks could predict poor motor, functional, and cognitive domains at 4.5-5 years. The authors demonstrated that this association was more robust when GMs was assessed closer to term (32).

Previous studies have shown that GMs is a reliable diagnostic method for assessing brain function in all neonates, but the impact of IUGR was controversial. Although any type of IUGR can cause neurological disorders in preterm infants.

The results of the present study showed significant associations between absence/abnormal FMs and abnormal ASQ scores in neurodevelopmental domains. Infants aged 2-5 months with absence/abnormal FMs had abnormal communication, problem-solving, social, and motor skills. This finding delineates that ASQ is an assessment method for neurodevelopmental delay screening among high-risk infants. Our study is one of the first studies showing a concordance between the quality of FMs and ASQ. This finding may propose ASQ as a cost-effective developmental screening tool for the early identification of developmental disorders in high-risk infants at ages 2-5 months for long-term follow-up and early medical/supportive interventions.

Strengths and Limitations

Our study had several limitations. Both groups in the present study were preterm, which may interrupt the effects of IUGR. Comparing variables between IUGR and healthy control groups may highlight the IUGR consequences. So, further studies with a larger sample size and considering such mentioned variables are suggested. Using Color Doppler for the diagnosis of IUGR was a strength of this study.

Conclusion

According to this study, no significant difference was detected between the IUGR and the Non-IUGR preterm infants regarding the absence/abnormal FMs. We also found that a history of IUGR was not a significant factor influencing ASQ scores. This means that a history of IUGR was not a responsible factor for absence/abnormal FMs or abnormal ASQ at ages 2 to 5 months.

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Conflicts of interest

The authors declare that there is no conflict of interest.

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