RISK FACTORS FOR GROSS MOTOR DYSFUNCTION OF LOWER LIMBS IN CHILDREN

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SUMMARY – The aim of this study was to identify risk factors for neurological development in children aged 1 to 3 years with a mild paraparesis form of motor development of lower extremities. Identification and follow-up of the neurorisk factors is important for early detection of neurodevelopmental deviations as well as for initiating early therapeutic treatments, which can improve the processes of brain plasticity and lead to recovery of the damaged function. Analysis of risk factors in children with paraparesis form of development revealed complicated pregnancy such as maternal diseases, fetal growth retardation or placental immaturity in 48% of these children; 26% of children were born before or after the term, and 34% had complications during delivery such as cesarean section or breech birth. In the present study, 80% of children with motor disabilities of lower extremities had Apgar index 10, 8% Apgar index 9, and only 12% had Apgar index lower than 8. Only 10% of 50 study children had normal ultrasound results, whereas cranial ultrasound abnormalities such as periventricular hemorrhage and intraventricular hemorrhage were recorded in 62% of the children.

Key words: *Lower extremity; Infant, premature; Cerebral palsy; Developmental disabilities; Motor skills*

Introduction

Paraparesis is a consequence of brain stroke (ischemic or hemorrhagic), asymmetric bleeding, or unilateral brain anomalies. Damage to the neural network causing paraparesis may occur prenatally, perinatally or postnatally, and is clinically manifested before the age of 2 or 3. The most common causes of paraparesis are hypoxia and ischemia, low birth weight, prematurity and chorioamnionitis. Types of brain dysfunction that are believed to be present in children with paraparesis can be divided into two groups: genetically determined maturation lag of skills related to motor development, and acquired neurological damage that can result in mild neurological and motor deficits or clearly defined neurological syndromes. Children with paraparesis usually have normal intelligence and can move independently[1], but most of them begin to walk with delay[2]. Advances in technology and care at neonatal intensive care units have provided a higher percentage of survival in children with brain dysfunctions and with very low birth weight, which has at the same time increased the number of children with paraparesis.

Symptoms of the risk of developing paraparesis are the signs of deviations from normal motor development resulting from impairments of the central nervous system. They are warning signs that should respond to appropriate therapy to prevent the development of clinical impairments of the central nervous system that lead to cerebral palsy. Symptoms of the

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risk of developing paraparesis are numerous, but most important are the following: when set up on the feet in standing position to rely on less than whole feet with or without crossing legs, rigidly extended or bent legs, lack of rotation of the belly to the back and *vice versa* at the age of 5-6 months, absence of independent sitting at the age of 7 months, and inability of independent standing and walking at the age of 10-14 months[3]. The diagnosis of cerebral palsy can be established by the first year of life. Therefore, early detection of deviations from normal motor development is very important[4]. Children with neurological risk have a history and/or clinical risk factors for early brain impairment. Children with high neurological risk are all infants with more than two history risk factors: children with the syndrome of spasticity and hypotonia, and children with brain ultrasound findings of cystic periventricular leukomalacia (cPVL), subcortical leukomalacia (SCL), middle cerebral artery infarction, intraventricular hemorrhage stage IV, and complicated intraventricular hemorrhage stage III. Children with low neurological risk factors are those where there are less than 2 history factors: children with the syndrome of dystonia and children with normal ultrasound findings or the findings of uncomplicated brain hemorrhage, i.e. subependymal hemorrhage (SEH) and intraventricular hemorrhage stage I-III[5].

Development of a child with cerebral palsy is determined by early recognition and early habilitation. According to the Surveillance of Cerebral Palsy in Europe, the diagnosis of cerebral palsy in infants is difficult to set up because of brain maturity[6]. Recent guidelines suggest the criteria for the diagnosis of cerebral palsy from the age of 5. For this reason, in this study we included children aged 1 to 3 years with mild paraparesis form of motor development of lower extremities. The assumption is that this mild paraparesis form of motor development of lower extremities is underlain by mild neurological impairments. The aim of this study was to identify the risk factors for neurological development in children from 1 to 3 years with a mild paraparesis form of motor development of lower extremities.

Patients and Methods

This retrospective study included 50 children aged 1 to 3 years and diagnosed with mild paraparesis (paraparesis and paraparesis discreta), hospitalized at Department of Pediatric Rehabilitation, University Department of Rheumatology, Physical Medicine and Rehabilitation, Sestre milosrdnice University Hospital Center. According to the cause of hospitalization, they were treated by a team of a physiatrist, an occupational therapist and a psychologist, and underwent examination by a neuropediatrician, which included bran ultrasound (US) scan. Retrospective analysis was accompanied by the following variables and processed for the purpose of determining the risk factors for neurological development in children with mild paraparesis of lower extremities, i.e. premature birth, complications during pregnancy, difficulties during delivery, birth weight and brain US. Data were collected by history, clinical evaluation by a physiatrist and psychologist, and by brain US scan. The criteria for preterm/premature infants were children born before 38th week of gestation. The criteria for complicated pregnancy were maternal infection during pregnancy, maternal diabetes mellitus, hypertension, maternal placental disorders, and bleeding in pregnancy. The criteria for difficult birth were cesarean section and breech position. The criteria for cranial US abnormalities were intracranial hemorrhage, cPVL, SCL, middle cerebral artery infarction, and SEH. Finally, the children with birth weight over 2500 g were considered as normal birth weight, while children below 2500 g were considered as low birth weight.

The Statistical Package for Social Sciences 13.0 (SPSS 13.0) intended for collecting data necessary for a retrospective analysis was used on statistical data analysis[7]. Statistical analysis was based on descriptive methods, frequencies and percentages.

Results

During the one-year study period, 50 children aged up to three years and diagnosed with paraparesis (male 56% and female 44%) were hospitalized at Department of Pediatric Rehabilitation. Of the total sample of 50 children, 40% were diagnosed with paraparesis and 60% with mild paraparesis (paraparesis discreta). According to age, 6% of the children were aged up to one, 78% up to two, and 16% up to three years.

In the present study, 52% of the children were born after normal pregnancy, while 48% were born

after complicated pregnancy such as maternal diseases, fetal growth retardation or placental immaturity (Table 1).

Of all study patients, 74% were born full-term (38th-40th week of gestation) and 26% were born before or after term (Table 2).

Table 1. Pregnancy complications in children with paraparesis

Pregnancy	Frequency	Percent
Normal	26	52
Complicated	24	48
Total	50	100

Of all study patients, 66% had normal delivery, while 34% had complications during delivery such as cesarean section or breech birth (Table 3).

Table 2. *Length of pregnancy in children with paraparesis*

Birth term	Frequency	Percent
On term	37	74
Before or 7 days after the term	13	26
Total	50	100

In this retrospective analysis, 80% of children with motor disabilities of lower extremities had Apgar index 10, 8% Apgar index 9, and only 12% had Apgar index lower than 8 (Fig. 1).

Table 3. Difficulties at delivery in children with paraparesis

Birth	Frequency	Percent
Normal	33	66
Complicated	17	34
Total	50	100

Of the 50 participants, only 10% had normal ultrasound results, while cranial ultrasound abnormalities such as periventricular hemorrhage (PVI) and intraventricular hemorrhage (IVH) were recorded in 62% of children; 28% of study children did not undergo cranial ultrasound evaluation (Fig. 2).

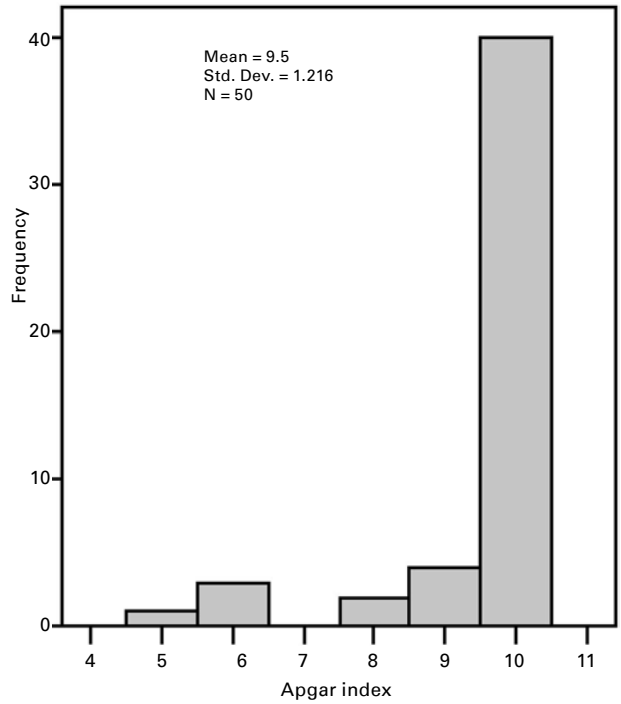

Fig. 1. Apgar index in children with gross motor dysfunction of lower limbs.

Finally, 47 children were classified as having normal birth weight (above 2500 g), whereas only three children had low birth weight (below 2500 g). In the study sample, the average birth weight of the patients

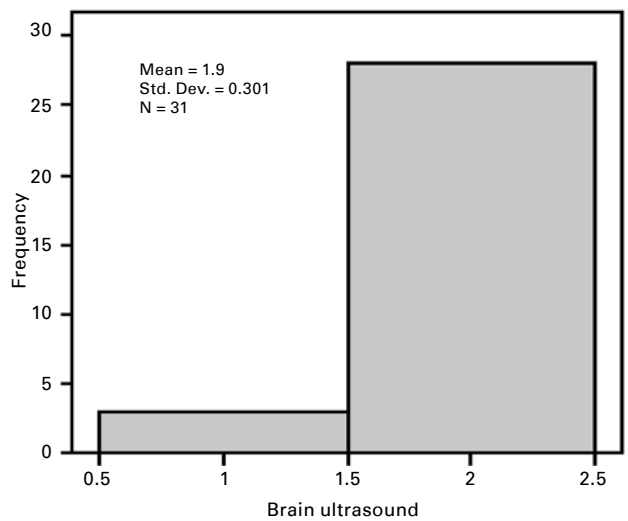

Fig. 2. Brain ultrasound in children with gross motor dysfunction of lower limbs.

1 = no abnormality detected; 2 = deviations from normal brain ultrasound results.

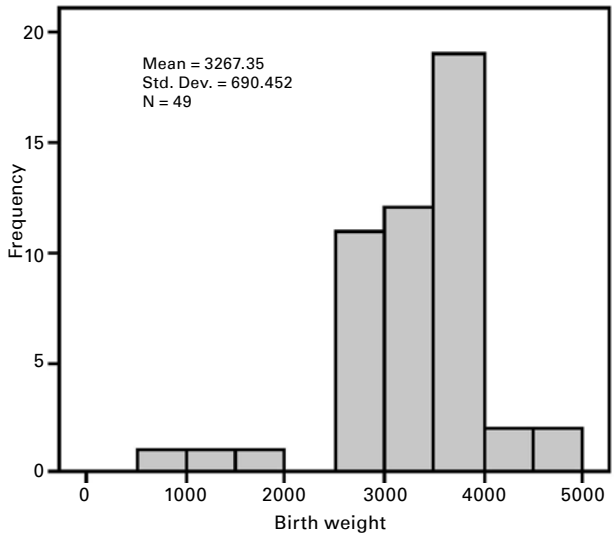

Fig. 3. Birth weight in children with gross motor dysfunction of lower extremities.

was 3275 g, the lowest birth weight was 930 g, and the highest birth weight was 4630 g (Fig. 3).

Discussion

According to the time of occurrence, neurorisk factors can be divided into those occurring during pregnancy, during delivery and early after birth. In the previous decade, many epidemiology studies were carried out. They have identified many factors for cerebral palsy development, proving that children with cerebral palsy are mostly born after abnormal pregnancies or deliveries[8].

During pregnancy, there are many risk factors that can endanger normal development of the fetus. Most commonly referred are anatomical and functional anomalies of the mother's reproductive system, the position of the placenta, amniotic fluid changes, inflammation of the amniotic fluid (amnionitis), too long or too short umbilical cord, maternal diseases during pregnancy, intrauterine infections and the use of medicine or drugs. These factors can cause prematurity, perinatal asphyxia and birth trauma (intracranial hemorrhage), which can all lead to the damage to the brain that can later manifest as a variety of neurodevelopmental disorders[9].

According to the World Health Organization, delivery from the 28th to 37th week is considered premature. Nowadays, the limit for preterm birth has moved lower, so the 24th week has been increasingly referred to as the lower limit. Children born before the 38th week of gestation, counting from the first day of the mother's last regular menstrual period, are considered premature newborns (premature). As for now, there is no known cause or causes of premature uterine activity, that is preterm birth, but the risk factors are known, i.e. diseases and conditions in pregnancy causing more frequent premature births. These include general maternal factors, diseases during pregnancy, uterine changes, placenta pathologies, fetal factors and iatrogenic factors (induction of labor). The study by Švaljug *et al*. has confirmed that 9%-11% of high-risk infants are born every year, and 80% of these infants are at neurorisk[10]. Also, the prevalence of cerebral palsy, one form of neuromotor damage in newborns, has not decreased and ranges from 1 to 2 *per* 1000 live births in the general population. In the study population of premature births, the prevalence is much higher, rating up to 100 *per* 1000. The leading risk factors are in the first place prematurity, especially before the 33rd week of gestation, low and very low birth weight, and in the perinatal period signs of asphyxia, convulsions, infant respiratory distress syndrome, early-onset and late-onset neonatal sepsis, meningitis, intracranial hemorrhage and hypoxic-ischemic encephalopathy. Finally, premature newborns are the highest-risk group for different impairments in psychomotor development, and a number of them even for the clinical picture of cerebral palsy. The risk of brain damage is greater as the gestational age and birth weight are lower, especially if preterm birth is caused by intrauterine infection, and if the newborn needs mechanical ventilation[10].

Perinatal risk factors include obstetric complications that lead to prolonged or premature birth and/or errors during birth process. These factors most often cause asphyxia, which is expressed as a low Apgar index. Significant reverse correlation between Apgar index and cerebral palsy was determined by analyzing the correlation of the most often used sign of asphyxia, Apgar index and cerebral palsy, in 26290 children[6,14]. Recent studies that define and grade asphyxia and cerebral palsy more precisely show that the occurrence of asphyxia as an etiological factor in children with cerebral palsy is just 8%-10%[10].

Cranial US is valuable in diagnosing early-onset brain abnormalities as the cause of paraparesis. In the past 20 years, intracranial US has become the method of choice in the diagnosis and follow up of the outcome of structural changes after perinatal brain damage, reliably demonstrating the type, localization and extent of damage, i.e. hypoxic-ischemic and peri-intraventricular hemorrhage.

In our sample, cranial US identified neurological abnormalities in a large number of children with paraparesis. Intracranial hemorrhage is frequent in the neonatal period, and the frequency and types of hemorrhage depend on gestational age. The lower the gestational age, the higher is the frequency of hemorrhage. According to the literature, 30% of children born with very low birth weight and having normal first and follow-up cranial US results developed cerebral palsy[11]. However, it is wrong to think that the impairments are not on the brain basis if magnetic resonance imaging or cranial US ultrasound do not indicate any changes. The impairments can be at the synaptic level. Furthermore, prenatal and postnatal damages caused by asphyxia often lead to developmental disorders without later visible macrostructural anomalies[12]. Even in many children with the clinical picture of paraparesis or tetraparesis, no neurological deficits need to be evident on US scan. It is highly important to detect neurological and neuropsychological abnormalities that may be associated with motor disabilities and also with other specific disabilities such as difficulties in speech and language development, difficulties in maintaining attention, difficulties in remembering, perception and the like.

Of the neurorisk children, especially vulnerable group are premature newborns (with low gestational age and low birth weight) because of the high incidence of hypoxic-ischemic and hemorrhagic brain lesions. According to many authors, a large number of children with extremely low birth weight (birth weight less than 1000 g) and with very low birth weight (birth weight less than 1500 g) develop some perceptual motor disability[13-15]. The study by Modrušan-Mozetić showed 26.5% of children with very low birth weight (less than 1500 g) to develop cerebral palsy[16].

Recognition and follow-up of children at a risk of neuromotor disability development (e.g., severe motor disabilities connected to lower extremities) and early initiation of therapeutic methods that can accelerate the processes of brain plasticity and lead to recovery of damaged function is of utmost importance. Rehabilitation of children at a risk of neuromotor disability development should start very early. Namely, the process of habilitation also represents secondary prevention of neurodevelopmental aberration.

Neurorisk factors occurring during delivery, which later lead to developmental disabilities, are perinatal asphyxia and birth trauma (subdural and subarachnoid hemorrhage).

Conclusion

Based on the study results, the risk factors for neurological development in children with mild paraparesis are premature infants, complications during pregnancy, difficult birth, and neurological impairments detected by cranial US. Low birth weight was confirmed in 2% of children with mild paraparesis. According to the literature, children with mild paraparesis fulfill the criteria for the low risk of neurodevelopmental delay. In the neonatal period, symptoms of mild paraparesis may remain unnoticed for a long time. Good prognostic factors for children at neurological risk for developing paraparesis in motor development are the history and neurological examination including brain US scan. It is important to detect infants with low and high neurological risk factors for developing paraparesis in order to include them in early habilitation treatment.

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Sažetak

ČIMBENICI NEURORIZIČNOSTI U DJECE S GRUBIM MOTORIČKIM DISFUNKCIJAMA DONJIH UDOVA

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Cilj istraživanja bio je utvrditi čimbenike rizika za neurološki razvoj u djece od 1. do 3. godine života s blažim paraparetskim obrascem razvoja motorike donjih udova. Prepoznavanje i praćenje neurorizičnih čimbenika važno je za rano otkrivanje neurorazvojnih odstupanja, kao i za ranu primjenu terapijskih postupaka koji mogu pospješiti procese plastičnosti mozga i dovesti do oporavka oštećene funkcije. Analizom čimbenika rizika kod djece s paraparetskim obrascem razvoja utvrđeno je slijedeće: 48% djece se rodilo iz kompliciranе trudnoće (infekcija majke u trudnoći, majčin dijabetes melitus, hipertenzija majke, bolesti posteljice, krvarenja u trudnoći), 26% djece je prijevremeno rođeno, dok su se u 34% djece potvrdila određena odstupanja u porodu (rođena na zadak ili carskim rezom). U provedenom istraživanju u 80% djece s motoričkim teškoćama u donjim ekstremitetima potvrdio se Apgar indeks 10, u 8% Apgar indeks 9, dok je samo 12% djece imalo Apgar indeks manji od 8. Od 50 sudionika samo 10% je imalo uredan nalaz ultrazvuka mozga, dok su u 62% slučajeva zabilježene određene abnormalnosti kao što su periventrikulsko krvarenje i intraventrikulsko krvarenje.

Ključne riječi: *Donji ekstremiteti; Nedonošče; Cerebralna paraliza; Razvojni poremećaji; Motoričke vještine*