The impact of sensory integration therapy on gross motor function in children after prenatal exposure to alcohol

Wpływ terapii integracji sensorycznej na funkcje motoryki dużej u dzieci po prenatalnej ekspozycji na alkohol

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Key words: physiotherapy, sensory integration, children after prenatal exposure to alcohol.

Słowa kluczowe: fizjoterapia, integracja sensoryczna, dzieci po prenatalnej ekspozycji na alkohol.

Abstract

Introduction: In Poland there are 900 cases of full-blown foetal alcohol syndrome (FAS) in neonates per year, and in 9000 children there are some symptoms of it.
Aim of the research: To analyse the impact of sensory integration (SI) therapy on gross motor skills function in children after prenatal exposure to alcohol.
Material and methods: The study was conducted on a group of 20 children aged 4–5 years with information from an interview about prenatal exposure to alcohol. The diagnosis of sensory integration disorder consisted of two 60-minute diagnostics meetings. Twelve trials with clinical observations were performed by Ayres: finger to nose, cocontraction, prone extension posture, flexed position supine, asymmetrical tonic neck reflex (ATOS), symmetrical tonic neck reflex (STOS), muscle tension, Schilder test, dynamic balance, static balance, gravitational insecurity, and trunk stabilisation. The therapeutic program included: normalisation of the vestibular and proprioceptive system, normalisation of the touch system, strengthening muscle tension, development of motion planning, development of oculomotor performance, development of motor coordination, hand therapy, integration of ATOS, STOS, development of locomotion and balance functions, and improving efficiency of gross and small motor skills.
Results and conclusions: High efficiency of SI therapy has been shown in children after prenatal exposure to alcohol on the example of gross motor skills. Positive effects of SI therapy have been shown for tests: finger to nose, in the erect position on the stomach, the flexural position on the back, ATOS, STOS, Schilder test, dynamic balance, static balance, and the uncertainty of gravity and trunk stabilisation. Only cocontraction and muscle tension tests showed no efficacy of SI therapy. The α-Cronbach position analysis showed high reliability of the performed tests both before and after the therapy. It is advisable to continue the study on a larger sample and observation of the functional status of children after therapy.

Streszczenie

Wprowadzenie: W Polsce stwierdza się rocznie 900 przypadków pełnoobjawowego alkoholowego zespołu płodowego u noworodków, natomiast u 9 tys. dzieci występowanie niektórych jego objawów.
Cel pracy: Analiza wpływu terapii integracji sensorycznej na funkcje motoryki dużej u dzieci po prenatalnej ekspozycji na alkohol.
Materiał i metody: Badanie przeprowadzono u 20 dzieci w wieku 4–5 lat z informacją z wywiadu o prenatalnej ekspozycji na alkohol. Wykonano 12 prób z obserwacji klinicznej wg Ayres: palec do nosa, kokontrakcja, pozycja wyprostna na brzuchu, pozycja zgięciowa na plecach, asymetryczny toniczny odruch szyi (ATOS), symetryczny toniczny odruch szyi (STOS), napięcie mięśni, test Schildera, równowaga dynamiczna, równowaga statyczna, niepewność grawitacyjna, stabilizacja tułowia. Program terapeutyczny obejmował: normalizację układu przedsionkowego i proprioceptywnego, normalizację układu dotykowego, wzmacnianie napięcia mięśniowego, rozwój planowania ruchu, rozwój sprawności okoruchowej, rozwój koordynacji ruchowej, terapię ręki, integrację ATOS, STOS, rozwój lokomocji i funkcji równoważnych, podnoszenie sprawności motoryki dużej i małej.
Wyniki i wnioski: Stwierdzono wysoką skuteczność terapii integracji sensorycznej u dzieci po prenatalnej ekspozycji na alkohol. Pozytywne efekty leczenia wykazano dla testów: palec do nosa, w pozycji wyprostnej na brzuchu, w pozycji zgięciowej na plecach, ATOS, STOS, Schildera. Potwierdzono również pozytywny wpływ terapii na równowagę dynamiczną, równowagę statyczną, niepewność grawitacyjną i stabilizację tułowia. Jedynie w teście na kokontrakcję i napięcie mięśni nie wykazano skuteczności terapii integracji sensorycznej. Analiza pozycji α-Cronbacha wykazała bardzo dużą rzetelność zastosowanych testów zarówno przed terapią, jak i po niej.

Introduction

The effect of consumption of ethyl alcohol by women during pregnancy on the foetus is a problem still poorly described and little known. In children whose mothers drank alcohol in small quantities, "occasionally", there are function problems that are difficult to diagnose and classify. In the case of minor symptoms in children with full symptomatic foetal alcohol syndrome (FAS) foetal alcohol effect is diagnosed [1–3, 7]. In these children there is often sensory integration dysfunction.

Aim of the research

The aim of the study was to analyse the impact of sensory integration (SI) therapy on gross motor function in children after prenatal exposure to alcohol.

Material and methods

The study was conducted on a group of 20 children (14 boys, 6 girls) aged 4–5 years with information from an interview about prenatal exposure to alcohol. Most of the children came from adoptive, foster families or children's homes. All the children were found with abnormal SI with dysfunctions typical of children with FAS spectrum, including: hyperactivity, tenacity, passivity, impulsiveness, irritability, sleep problems, anger, hypersensitivity to touch and sound, difficulty in adaptation, problems with organisation, low self-esteem, difficulty with self-control, ease of falling into depression. The diagnosis of sensory integration disorder consisted of two 60-minute diagnostics meetings. Diagnosis of SI consisted of: an interview with a parent/guardian, observation of controlled and free movements of the child in the therapeutic hall, response to sensory stimuli administered, as well as clinical observation. The main areas of evaluation and control were: gross motor skills, small motor skills, muscular tension, as well as balance responses of the body. In this work, because of the breadth of statistical analysis, only the effect of therapy on SI gross motor function is shown. Motility refers to the dexterity of movement of the whole body. Gross motility refers to movement efficiency of the whole body. Awkwardness specific symptoms are the following:

– delays in motor development in infants and toddlers and little physical activity,
– general physical awkwardness and minimal mastering in terms of strong movements associated with disturbances of muscle tone (excessive or too low tension),
– lack of coordination of movements with the collaboration of different muscle groups, giving the impression of a general awkwardness,
– delay in achieving, compared with peers, different motor skills in daily activities, and playground and sports activities,
– general slowness of movement,
– avoiding movement games,
– disruption of visual-motor coordination in games and tasks, in which the movement takes place under visual control (ball throwing, hopscotch).

Twelve trials were performed with clinical observations by Ayres: finger to nose, cocontraction, prone extension posture, flexed position supine, asymmetrical tonic neck reflex (ATOS), symmetrical tonic neck reflex (STOS), muscle tension, Schilder test, dynamic balance, static balance, gravitational insecurity, and trunk stabilisation. Each child regularly, once a week, for the period from 01.09.2011 to 28.02.2012 (6 months) participated in a 1-hour SI therapeutic session. The therapeutic program included: the normalisation of the vestibular and proprioceptive system, normalisation of the touch system, strengthening muscle tone, development of motion planning, the development of oculomotor performance, the development of motor coordination, hand therapy, integration of asymmetrical tonic neck reflex (ATOS), symmetrical tonic neck reflex (STOS), the development of locomotion and balance functions, and raising the efficiency of gross and small motor skills. Treatments were carried out in individually selected programs [4–6, 8]. In addition, in children with tactile defence, the implementation of Wilbarger massage in home conditions was recommended. The study was conducted at the Centre for Advanced Physiotherapy Tactum Sanitas in Kielce. After 6 months of therapy 12 trials were repeated with clinical observation by Ayres. Measurement data was collected in the spreadsheet program Microsoft MS Excel and pre-treated was imported into StatSoft Statistica. Data analysis consisted of anthropometric characteristics (height, body mass, body mass index (BMI)) and tests for SI.

Statistical analysis

Basic statistical parameters were calculated, such as the arithmetic mean (x), standard deviation (SD), median (Me), skewness (Sk) and kurtosis (Ku), as well as extreme values and confidence intervals for the level of 95%. Variables were verified in terms of normality of distribution by Shapiro-Wilk test. An analysis of the reliability of Cronbach's α position was also carried out. To demonstrate the differences between the tests before and after SI therapy, Wilcoxon matched pairs test was used [17].

Results

The mean age was 4.45 ±0.51 years, average body height of the subjects 1.01 ±0.03 m, body weight 16.35 ±1.34 kg, mean BMI 15.73 ±0.52 (Table 1). Gross motor test results before SI therapy showed: finger to nose (x = 2.1), cocontraction (x = 3), erect position on the stomach (x = 3.5), the position of flexion on the back (x = 3.55), ATOS (x = 2.1), STOS (x = 2.1), muscle tension (x = 2.55), Schilder test (x = 1.25), dynamic bal-

ance ($x = 0.95$), static balance ($x = 0.7$), the uncertainty of gravity ($x = 1.8$), trunk stabilisation ($x = 1.5$), gross motor skills – overall result ($x = 2.092$) (Table 2). Gross motor test results after SI therapy showed: finger to nose ($x = 3$), cocontraction ($x = 3$), erect position on the stomach ($x = 4.95$), the position of flexion on the back ($x = 3.95$), ATOS ($x = 3$), STOS ($x = 3$), muscle tension ($x = 2.55$), Schilder test ($x = 2.15$), dynamic balance ($x = 2.85$), static balance ($x = 2, 4$), the uncertainty of gravity ($x = 2.95$), trunk stabilisation ($x = 2$) gross motor skills – overall result ($x = 3.008$) (Table 3).

A significant result of the Shapiro-Wilk test shows that the distribution of the observed variable (gross motor) is not similar to a normal distribution (Table 4).

Cronbach's α value ranges from 0 to 1. The higher the value, the greater the reliability of the scale. It is assumed that values above 0.7 indicate the correct scale reliability. The α-Cronbach position analysis showed high reliability of the tests used both before and after therapy (Tables 5, 6). Wilcoxon matched pair test of gross motor showed significant differences in tests before and after SI therapy ($p < 0.001$) (Tables 7–9). High efficiency of SI therapy has been shown in children after prenatal exposure to alcohol on the example of gross motor skills. The positive effects of SI therapy have been shown for tests: finger to nose ($p < 0.001$), in the erect position on the stomach ($p < 0.001$), in a flexural position on the back ($p < 0.05$), ATOS ($p < 0.001$), STOS ($p < 0.001$), Schilder ($p < 0.001$), for dynamic balance ($p < 0.001$), static balance ($p < 0.001$), the uncertainty of gravity ($p < 0.001$), and trunk stabilisation ($p < 0.001$). In the cocontraction test and muscle tension there has been no efficacy of SI shown (Tables 10, 11).

Discussion

The report of the Birth Defects Monitoring Program completed by the Centres for Disease Control

Table 1. Anthropometric data of respondents

Variables	*N* valid	Mean	Median	Minimum	Maximum	Standard deviation	Skewness	Kurtosis
Age	20	4.45	4	4	5	0.510	0.218	–2.183
Body height	20	1.018	1.02	0.94	1.08	0.036	–0.393	–0.228
Body mass	20	16.35	16	14	19	1.348	0.283	–0.771
Body mass index	20	15.738	15.893	14.704	16.340	0.527	–0.671	–0.666

Table 2. Gross motor skills before SI therapy

Gross motor test	*N* valid	Mean	Median	Minimum	Maximum	Standard deviation	Skewness	Kurtosis
Finger to nose test	20	2.1	2	2	3	0.308	2.888	7.037
Cocontraction test	20	3	3	3	3	0.000		0.000
Erect position on stomach test	20	3.5	3.5	1	5	0.889	–0.750	2.285
Position of flexion on back test	20	3.55	4	1	4	0.759	–2.191	5.892
Test for ATOS	20	2.1	2	2	3	0.308	2.888	7.037
Test for STOS	20	2.1	2	2	3	0.308	2.888	7.037
Muscle tension	20	2.55	3	2	3	0.510	–0.218	–2.183
Schilder test	20	1.25	1	0	2	0.550	0.132	–0.076
Dynamic balance test	20	0.95	1	0	1	0.224	–4.472	20.000
Static balance test	20	0.7	1	0	1	0.470	–0.945	–1.242
Uncertainty of gravity test	20	1.8	2	1	3	0.616	0.120	–0.207
Trunk stabilisation	20	1.5	2	0	3	0.889	–0.250	–0.497
Gross motor – overall result	20	2.092	2.167	1.167	2.833	0.388	–0.109	0.985

Table 3. Gross motor skills after SI therapy

Gross motor test	*N* valid	Mean	Median	Minimum	Maximum	Standard deviation	Skewness	Kurtosis	Difference
Finger to nose test	20	3	3	3	3	0.000	0.000	0.000	0.900
Cocontraction test	20	3	3	3	3	0.000	0.000	0.000	0.000
Erect position on stomach test	20	4.95	5	4	5	0.224	–4.472	20.000	1.450
Position of flexion on back test	20	3.95	4	3	4	0.224	–4.472	20.000	0.400
Test for ATOS	20	3	3	3	3	0.000	0.000	0.000	0.900
Test for STOS	20	3	3	3	3	0.000	0.000	0.000	0.900
Muscle tension	20	2.55	3	2	3	0.510	–0.218	–2.183	0.000
Schilder test	20	2.15	2	2	3	0.366	2.123	2.776	0.900
Dynamic balance test	20	2.85	3	2	3	0.366	–2.123	2.776	1.900
Static balance test	20	2.4	3	1	3	0.940	–0.945	–1.242	1.700
Uncertainty of gravity test	20	2.95	3	2	3	0.224	–4.472	20.000	1.150
Trunk stabilisation	20	2.3	2	1	3	0.733	–0.553	–0.834	0.800
Gross motor – overall result	20	3.008	3.083	2.500	3.250	0.213	–1.115	0.571	0.920

(CDC), based on data from 1500 hospitals, suggests that the prevalence of reported FAS cases in the U.S. population is 0.3–0.9 per 10,000 births [9]. On the other hand, Abel and Sokolow, after reviewing 19 epidemiological works from around the world, evaluated the prevalence of FAS at 1.9 per 1000 live births [9]. According to the CDC report, incidence rates of FAS in 10,000 births vary depending on the ethnicity of mothers [9]. The world incidence of FAS is estimated at 3–9 per 1000 live births [9]. In Poland there are 900 cases of full-blown FAS in neonates per year, and in 9000 children there are some symptoms of it [15, 16]. The study conducted at the Institute of Mother and Child in Warsaw, under the guidance of Prof. Krzysztof Niemiec, involving the tests of urine samples of pregnant women, who reported abstinence, for the presence of indicators of alcohol decay (β-hexosaminidase and γ-glutamyl) showed that one third of women drank alcohol while knowing about their pregnancy [7]. A survey made in the Sopot Laboratory of Social Research in 2005 on behalf of PARPA, on a representative group of 1038 women in reproductive age (18–40 years), showed that one third of the women drank alcohol during pregnancy [7]. Most common among the women who admitted to drinking during pregnancy were those with secondary education, and the least common were women with primary education. Most of the women who drank were from small and medium-sized cities, and the least from large cities and the countryside. The IBSOS laboratory, on behalf of the foundation "Rodzić po ludzku", in 2005 conducted a survey on a representative sample of 1000 Poles aged 15 and above. One third of the women (33.5%) who gave birth to one or more children admitted consuming small amounts of alcohol during pregnancy. Although 83% of the respondents had heard that even the smallest amount of alcohol could be dangerous, one third (31.7%) said that a small amount of alcohol could have a positive

Table 4. Shapiro-Wilk test of normality of distribution of gross motor skills

Before therapy			After therapy		
N	*W*	*p*	*N*	*W*	*p*
20	0.947	0.31865	20	0.878	0.016

Table 5. Analysis of reliability of α-Cronbach position before SI therapy

Gross motor test	Mean – when removed	Value when removed	Standard deviation when removed	Total position correlation	α when removed
Finger to nose test	6.555	1.579	1.256	0.605	0.899
Cocontraction test	6.255	1.741	1.319	–0.175	0.912
Erect position on stomach test	6.555	1.331	1.154	0.949	0.878
Position of flexion on back test	6.367	1.387	1.178	0.732	0.891
Test for ATOS	6.905	1.657	1.287	0.629	0.904
Test for STOS	6.555	1.579	1.256	0.605	0.899
Muscle tension	6.405	1.439	1.200	0.689	0.893
Schilder test	6.838	1.408	1.186	0.710	0.892
Dynamic balance test	6.938	1.641	1.281	0.505	0.904
Static balance test	7.021	1.484	1.218	0.628	0.896
Uncertainty of gravity test	6.655	1.317	1.148	0.835	0.884
Trunk stabilisation	6.755	1.141	1.068	0.836	0.893

Table 6. Analysis of reliability of α-Cronbach position after SI therapy

Gross motor test	Mean – when removed	Value when removed	Standard deviation when removed	Total position correlation	α when removed
Finger to nose test	9.545	0.646	0.804	–0.156	0.732
Cocontraction test	9.545	0.646	0.804	0.238	0.732
Erect position on stomach test	9.555	0.611	0.782	0.481	0.715
Position of flexion on back test	9.557	0.603	0.777	0.470	0.712
Test for ATOS	10.045	0.646	0.804	0.146	0.732
Test for STOS	9.545	0.646	0.804	0.196	0.732
Muscle tension	9.695	0.467	0.684	0.666	0.656
Schilder test	9.828	0.587	0.766	0.247	0.722
Dynamic balance test	9.595	0.507	0.712	0.734	0.662
Static balance test	9.745	0.314	0.560	0.698	0.670
Uncertainty of gravity test	9.561	0.594	0.771	0.415	0.710
Trunk stabilisation	9.778	0.408	0.638	0.598	0.670

effect for the mother and child. Expertise drawn up on the basis of a nationwide survey in 2009 showed that 29% of women consuming alcohol in the last year were pregnant [7]. The effect of ethyl alcohol on the foetus is a problem that is still poorly described and little known. In children whose mothers drank alcohol there are functional difficulties that are difficult to diagnose and classify, and often sensory integration dysfunction. For these children SI therapy is necessary and effective [10–16, 18–33]. This work, because of the breadth of statistical analysis, only shows the effects of SI therapy on gross motor function. This motility refers to the dexterity of movement of the whole body. Therapies were carried out via individually selected programs [4–6, 8]. In addition, in children with tactile defence, the implementation of Wilbarger massage in home conditions was recommended. Similar results of the therapy were obtained in studies of

Table 7. The standardised results of gross motor tests before SI therapy

Motor gross tests	*N* valid	Mean	Median	Minimum	Maximum	Standard deviation
Finger to nose test	20	0.700	0.667	0.667	1.000	0.103
Cocontraction test	20	1.000	1.000	1.000	1.000	0.000
Erect position on stomach test	20	0.700	0.700	0.200	1.000	0.178
Position of flexion on back test	20	0.888	1.000	0.250	1.000	0.190
Test for ATOS	20	0.350	0.333	0.333	0.500	0.051
Test for STOS	20	0.700	0.667	0.667	1.000	0.103
Muscle tension	20	0.850	1.000	0.667	1.000	0.170
Schilder test	20	0.417	0.333	0.000	0.667	0.183
Dynamic balance test	20	0.317	0.333	0.000	0.333	0.075
Static balance test	20	0.233	0.333	0.000	0.333	0.157
Uncertainty of gravity test	20	0.600	0.667	0.333	1.000	0.205
Trunk stabilisation	20	0.500	0.667	0.000	1.000	0.296
Gross motor – overall result	20	0.605	0.628	0.343	0.819	0.113

Table 8. The standardised results of gross motor tests after SI therapy

Motor gross tests	*N* valid	Mean	Median	Minimum	Maximum	Standard deviation	Difference K-P
Finger to nose test	20	1.000	1.000	1.000	1.000	0.000	0.300
Cocontraction test	20	1.000	1.000	1.000	1.000	0.000	0.000
Erect position on stomach test	20	0.990	1.000	0.800	1.000	0.045	0.290
Position of flexion on back test	20	0.988	1.000	0.750	1.000	0.056	0.100
Test for ATOS	20	0.500	0.500	0.500	0.500	0.000	0.150
Test for STOS	20	1.000	1.000	1.000	1.000	0.000	0.300
Muscle tension	20	0.850	1.000	0.667	1.000	0.170	0.000
Schilder test	20	0.717	0.667	0.667	1.000	0.122	0.300
Dynamic balance test	20	0.950	1.000	0.667	1.000	0.122	0.633
Static balance test	20	0.800	1.000	0.333	1.000	0.313	0.567
Uncertainty of gravity test	20	0.983	1.000	0.667	1.000	0.075	0.383
Trunk stabilisation	20	0.767	0.667	0.333	1.000	0.244	0.267
Gross motor – overall result	20	0.879	0.903	0.726	0.958	0.069	0.274

a population of children with developmental disabilities from Kielce town. These were studies carried out on a group of 153 children admitted for treatment in their third year of life. The aim of this study was to analyse the impact of integrating the senses (mostly proprioception and the vestibular system) on vocabulary development. The results of the diagnosis of sensory integration processes show that the most affected areas are associated with static and dynamic balance and after-rotation nystagmus. They also indicate significant disorders of the development of the vestibular system. Early diagnosis of sensory integration disorders in the population will significantly prevent more serious problems in the development of children. Disorders of sensory integration processes impede the normal development of speech and language. The largest deficits in the area of vocabulary

Table 9. Wilcoxon matched pair test of gross motor

Gross motor before and after the therapy	*N* valid	*T*	*Z*	*P*-value
	20	0	3.919	0.001

Table 10. Wilcoxon matched pair test of gross motor

Motor gross tests	Initial test		Final test		Difference K-P	Wilcoxon test
	N valid	Mean	*N* valid	Mean		*N* valid
Finger to nose test	20	2.1	20	3	0.9	< 0.001
Cocontraction test	20	3	20	3	0	–
Erect position on stomach test	20	3.5	20	4.95	1.45	< 0.001
Position of flexion on back test	20	3.55	20	3.95	0.4	< 0.05
Test for ATOS	20	2.1	20	3	0.9	< 0.001
Test for STOS	20	2.1	20	3	0.9	< 0.001
Muscle tension	20	2.55	20	2.55	0	–
Schilder test	20	1.25	20	2.15	0.9	< 0.001
Dynamic balance test	20	0.95	20	2.85	1.9	< 0.001
Static balance test	20	0.7	20	2.4	1.7	< 0.001
Uncertainty of gravity test	20	1.8	20	2.95	1.15	< 0.001
Trunk stabilisation	20	1.5	20	2.3	0.8	< 0.001

Table 11. Wilcoxon matched pair test of gross motor for standardised values

Motor gross tests	Initial test		Final test		Difference K-P	Wilcoxon test
	N valid	Mean	*N* valid	Mean		Value of *p*
Finger to nose test	20	0.700	20	1.000	0.9	< 0.001
Cocontraction test	20	1.000	20	1.000	0	–
Erect position on stomach test	20	0.700	20	0.990	1.45	< 0.001
Position of flexion on back test	20	0.888	20	0.988	0.4	< 0.05
Test for ATOS	20	0.350	20	0.500	0.9	< 0.001
Test for STOS	20	0.700	20	1.000	0.9	< 0.001
Muscle tension	20	0.850	20	0.850	0	–
Schilder test	20	0.417	20	0.717	0.9	< 0.001
Dynamic balance test	20	0.317	20	0.950	1.9	< 0.001
Static balance test	20	0.233	20	0.800	1.7	< 0.001
Uncertainty of gravity test	20	0.600	20	0.983	1.15	< 0.001
Trunk stabilisation	20	0.500	20	0.767	0.8	< 0.001

development were reported in the area of creating sub words and defining concepts in connection with disturbances in dynamic and static balance. There was also a correlation between vestibular system disorders and acquiring vocabulary skills [34–36].

Conclusions

A high efficiency of SI therapy has been shown in children after prenatal exposure to alcohol in the example of gross motor skills. Positive effects of SI therapy have been shown for trials: finger to nose, in the erect position on the stomach, in the flexural position on the back, ATOS, STOS, Schilder, for dynamic balance, static balance, the uncertainty of gravity, and trunk stabilisation. Only in the cocontraction and muscle tension tests was no efficacy of SI shown. The analysis of the reliability of α-Cronbach position showed high reliability of the tests before and after therapy. It is advisable to continue the study on a larger sample as well as observation of the functional status of children after therapy.

Conflict of interest

The authors declare no conflict of interest.

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