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Ocena pozycji siedzącej u niemowląt

Evaluation of sitting position in infants

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Streszczenie:

Wstęp. Diagnostyka funkcjonalna niemowląt stanowi ogromne wyzwanie dla lekarzy pediatrii, neurologii dziecięcej oraz fizjoterapeutów. W pracy oceniano pozycję siedzącą przy wykorzystaniu stanowiska podoskopowego PodoBaby przeznaczonego do diagnostyki niemowląt.

Cel pracy. Celem pracy była ocena motoryki spontanicznej w zakresie pozycji siedzącej niemowląt zdrowych poprzez analizę płaszczyzn przylegania do podłoża w obrazie podoskopowym.

Materiał i metody. Badania zostały przeprowadzone w grupie dzieci uczęszczających do szkoly pływania „TONI" we Wrocławiu dla niemowląt i małych dzieci. Badaniami objęto 25 niemowląt siedzących w wieku 8-16 miesiąca życia. Badanie zostało przeprowadzone w pozycji siedzącej na wielkogabarytowym stanowisku podoskopowym do diagnozy niemowląt PodoBaby.

Wyniki i wnioski. Pozycja siedząca opisywana wielkością płaszczyzn przylegania jest prawidłowa tak u niemowląt zdrowych jak i u niemowląt z bardzo lekkim ZOKN. U niemowląt zdrowych jest stabilna a nieco mniej stabilna u niemowląt z bardzo lekkim ZOKN. Pewne różnice jakości pozycji siedzącej niemowląt zdrowych względem niemowląt z bardzo lekkim ZOKN mogą stanowić podłoże działań profilaktycznych w zakresie wad postawy ciała.

Słowa kluczowe:

pozycja siedząca dziecka, niemowlęta, zaburzenia ośrodkowej koordynacji nerwowej (ZOKN), podoskop

Abstract

Introduction. Functional diagnostics of infants poses a great challenge to pediatricians, pediatric neurologists and physiotherapists. The study assessed the sitting position using the PodoBaby podoscopic station dedicated to the diagnostics of infants.

Objective. The goal of the study was to assess the spontaneous motor activity of healthy infants in sitting position by analyzing the contact areas in podoscopic images.

Material and Methods. The study was conducted in a group of infants attending the "TONI" swimming school for infants and small children in Wrocław. A total of 25 sitting infants aged 8-16 months were included in the study. Examination were carried out in sitting position using a large-dimensional PodoBaby podoscopic station dedicated to the diagnostics of infants.

Results and Conclusions. Sitting described the size of the of the contact areas is correct as healthy as infants and in infants with very light CCD. Infants healthy sitting position is stable. Sitting infants with very light CCD is a little less stable than in infants healthy. Certain differences in the quality of infant healthy seated position relative to infants with very light CCD can provide the support of prevention activities in the field of body posture.

Key words:

baby sitting position, central coordination disturbance (CCD), podoscope

Introduction

Functional diagnostics of infants poses a great challenge to pediatricians, physiotherapists and pediatric neurologists of today.

Current diagnostic methods, although highly valued for their usefulness, belong rather to the subjective methods for the assessment of the psychomotor development of a child [1, 2].

According to current estimates, the number of children with cerebral palsy in the US and Europe is 2-3 per 1000 live births [1].

The "motor poverty" of children in the first three months of their lives makes diagnostics more difficult and requires the challenge of more detailed analysis i.e. if understanding the quality of a partial pattern in the context of a full motor pattern. Thus, appropriate diagnostic approach and appropriate selection of treatment are of utmost importance [3, 4].

Inability to assess the psychomotor development of the child may lead to incorrect diagnosis and treatment. Such situation requires the development of an objective assessment method that could be used as an auxiliary tool to support and confirm the clinical diagnosis [1, 4, 5].

The human body is equipped with a congenital, genetically encoded development mechanism that allows for sequential mastering the skills of maintaining one's posture, verticalization, and performance of appropriate movements. The children are equipped with these developmental potential in their genetic code passed over from their parents and develop appropriate abilities owing to the proper development and functioning of the nervous system occurring under the influence of external stimuli [6].

The proper motor development in the neonatal period and infancy is described in detail in the papers by Banaszek [7] and Surowińska [8].

Ability to adopt the sitting position is one of the stages of the correct development of a child. Depending on the size postural tone evaluate the possibility of antigravity muscle work. If there is a disparity in suspense it comes to compensation antigravity mechanism. The performance potential of antigravitational muscles is assessed in relation to the postural tone; autocompensation of the antigravity mechanism is observed in case of any disproportions in muscle tone. The disturbed distribution of muscle tone is associated with the predominance of flexion- or extensiontype positioning of individual body segments as well as with the shift in the position of the body's center of gravity to the front, to the back, or sidewards from the longitudinal body axis [9, 10, 11]. The sitting position, being one of the desirable manifestations of the proper motor pattern, is achieved by the child at the age of about 8-9 months. Earlier, i.e. as early as at about 7 months, the infant is capable of remaining in the inclined sitting position while supporting themselves with one or both upper limbs, and then to sit up starting from crawling position [9].

Disintegration of the central nervous system which coordinates and organizes all behaviors as well as integrates the motor organ is at the origin of all developmental disorders [2].
At early developmental stages, muscle tone distribution disturbances are manifested by certain abnormal infant's postures and reactions that may provide the first warning signs before the development of the full pathological image [12].
Abnormal functioning of the central nervous system in infants is referred to as central coordination disturbances (CCD). One of the diagnostic methods established in Poland is the assessment of postural reflexes according to Vojta. The method is used to determine the degree of central coordination disturbances and thus the risk of abnormal development:
• Very mild CCD: 1-3 out of 7 reactions disturbed;
• Mild CCD: 4-5 out of 7 reactions disturbed;
• Moderate-to-severe CCD: 6-7 out of 7 reactions disturbed;
• Severe CCD: all reactions abnormal and accompanied by severe muscle tone disturbances [13, 14, 15].

Objective

The objective of the study was to assess the spontaneous motor activity in sitting position in healthy infants as compared to infants with very mild central coordination disturbances by means of analyzing the size of the support contact areas using the PodoBaby podoscopic station dedicated to the diagnostics of infants.
Answers to the following research questions were sought for when analyzing the study results:
1. What is the distribution of contact areas in the sitting position in healthy infants?
3. Is the location of contact areas within individual frames subject to changes over the course of the study?
4. Are there any clear differences between the distribution of contact areas in sitting position in healthy infants and infants with very mild central coordination disturbances?

Material

The study was conducted in a group of infants attending the "TONI" swimming school for infants and small . The study was conducted in a group of 25 infants who had reached the sitting postural stage, i.e. who were able to sit up by themselves and remain sitting for a longer while. The age of the subjects was 9 through 18 months (1.5 year). The mean age was 9.98 months.
The study included all children whose parents agreed for their child's participation and declared their child to be healthy. The assessment of psychomotor development revealed that eight of the children had very mild central coordination disturbances. During the course of the

study, a decision was made to compare the results obtained in both groups. A total of 17 healthy children at mean age of 9.9 months were examined. The average age of the 8 children with very mild central coordination disturbances was 10 months.

Methods

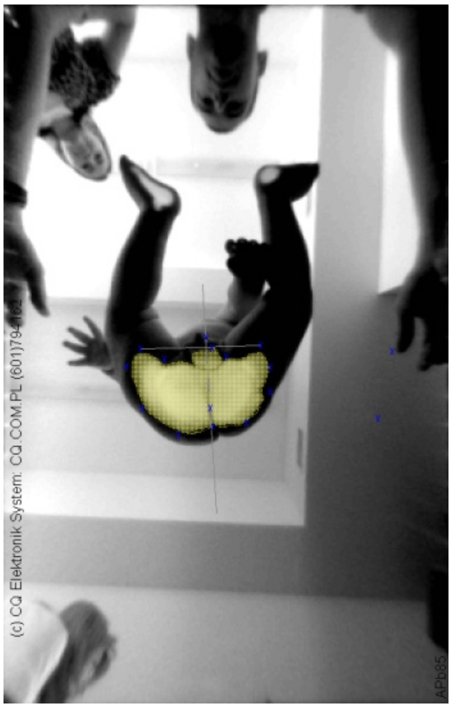
The PodoBaby station is a large-dimensional device consisting of a computer-assisted podoscope and a digital camera. The device facilitates objective assessments of the distribution and size of contact areas in relation to the outline of the entire body projection in prone and supine positions as well as determination of angular and longitudinal parameters of selected body segments. During the study, the infant lies on the podoscope plate while a digital photograph is taken from below for further processing and analysis using a computer. Thanks to the digital camera integrated with the device, spontaneous motor activity of the infant may be recorded. The device permits to carry out measurements of infants and children up to the weight of 25 kg, both healthy and with developmental disorders, up to the age of ca. 3 years. The computational accuracy is 0.1 mm and 0.1 degree. The frame recording frequency is 1 frame per second. Examination using the PodoBaby station is non-invasive and may thus be repeated many times without any adverse consequences for the patients [4].

Technical parameters of instrumentation

• dimensions: 900 x 600 x 550 x 750 mm,
• weight: 30 kg,
• examination area: 800 x 500 mm,
• image resolution: 480 x 570 pixels,
• calculation accuracy: 1 mm; 0.1 degree,
• frame frequency: 1 frame/s.

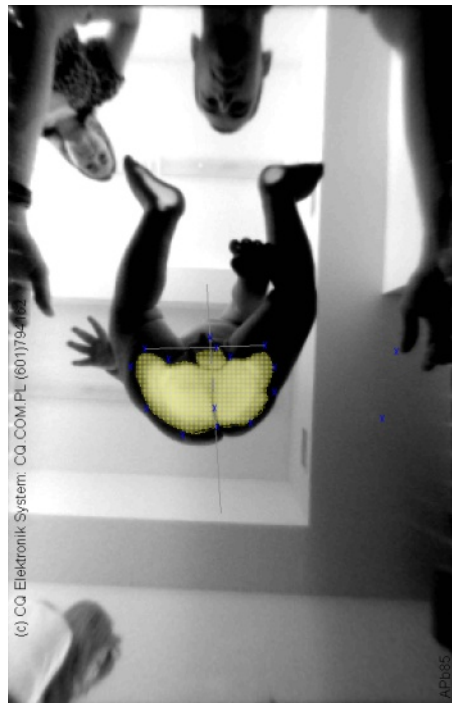
Examination conditions and summary

Each examination was conducted by two investigators and the infant's parent. No other individuals were allowed in the study room so as not to distract the child. The room was always darkened so as to minimize visual stimuli and the podoscopic device was always located in the same place.The image was recorded with the child in sitting position. In every examination, the investigator stood behind the infant's head and the parent stood in front of the infant's feet. Frame recording started from propping the baby to the sitting position. During the test, the child has eye contact with the parent who takes care of your child focused their attention on him.
Thirty sequential frames were recorded. however statistical analysis was subjected to a every fifth frame (5 seconds) starting from the fifth (5, 10, 15, 20, 25). The total size of the contact area [mm2], the size of the contact area on the left and right of the natal cleft [mm^2], and the percentage of the contact area of the left or right relative to the total plane of adhesion [%].



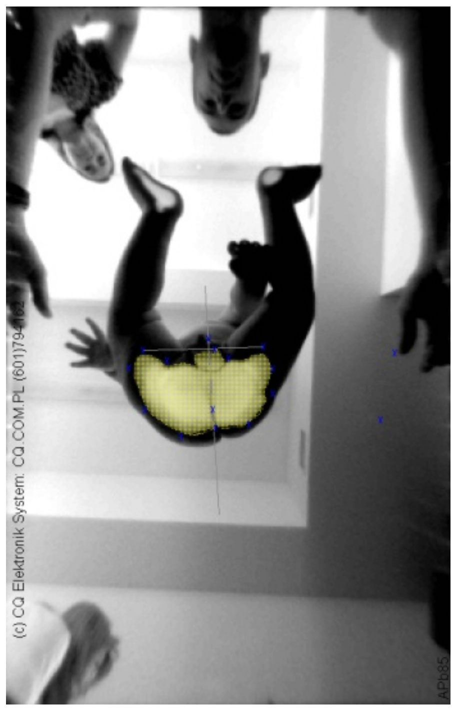
Frame 5

Frame 10



Frame 15

Frame 20



Frame 25

Fig. 1. Sitting position of a 10-month-old infant in an example podoscopic examination: frames 5, 10 , 15, 20, 25

Table 1. The size of contact areas [mm^2] and the percentage list of areas within the trunk-hip belt region in individual frames (5, 10, 15, 20, 25) of podoscopic examination of a 10-month-old infant in sitting position

Sequence	Frame	Overall contact area [mm^2]	Contact area, right side		Contact area, left side	
			[mm2]	%	[mm2]	%
1	5	11780	6609	56,10	5171	43,9
2	10	10737	5215	48,57	5522	51,43
3	15	12604	6644	52,71	5960	47,29
4	20	12516	6232	49,79	6284	50,21
5	25	9286	4514	48,61	4772	51,39
Total			5842,8		5541,8	
Mean				51,16		48,84

Table 2. Location of all contact areas of a 10-month-old infant during a podoscopic examination in sitting position: frames 5, 10, 15, 20, 25

Frame	Location of all contact areas
Frame5	Right foot, left heel, right buttock and left buttock
Frame10	Right foot right buttock and left buttock
Frame15	Right foot right buttock and left buttock
Frame 20	Right foot right buttock and left buttock
Frame 25	Right foot, left heel, right buttock and left buttock

An example podoscopic examination of a 10-month-old child is presented in Figure 1. For better understanding of the quality of the infant's sitting position, individual values of contact areas [mm^2] and percentages of left/right-side areas within the trunk/hip belt region in individual frames (5, 10, 15, 20, 25) are listed in Table 1.

Location of all contact areas in individual frames is described in Table 2.

Statistical processing

Statistica software was used for the processing of study data. Shapiro-Wilk's test for normal distribution and Student's t-test were used. Mean values of contact areas as well as the left-side contact areas and right-side contact areas were also determined for 5 frames in the entire study group.

Results

Was analyzed differences in the size distribution of the contact areas between the two groups of infants using the Student's t test for independent groups in the individual frames and the average across all of the five shots left and right. In the frame of 5, 10, 15, 20 and 25 and the average of all the frames left there was a statistically significant differences in the parameters between 1 and 2 group of children. The frame 15 and right side 20 also demonstrated statistically significant differences (Table 3).

Table 3. Independent samples t-test results

Variable	t-tests; Grouping: Group 1 :1 Group 2 : 2					
	Mean 1	Mean 2	SD 1	SD 2	F ratio Variances	p Variances
F5R	6738.125	6313.471	1904.189	1510.846	1.588474	0.418563
F5L	6444.125	5981.412	2780.535	1154.495	5.800600	**0.003521**
F10R	5969.500	6237.294	2636.939	1556.445	2.870335	0.076479
F10L	6038.625	5972.941	2937.313	984.816	8.895905	**0.000328**
F15R	5423.125	6300.235	3080.300	1448.817	4.520216	**0.011897**
K15L	5831.750	6215.529	2804.487	1083.144	6.704013	**0.001638**
K20R	5717.625	6214.824	2621.195	1315.658	3.969285	**0.021269**
K20L	6372.875	6218.588	2767.547	1018.270	7.386936	**0.000959**
K25R	6803.500	6145.235	1567.643	1463.144	1.147941	0.766637
K25L	5881.875	5934.882	3299.577	1184.056	7.765545	**0.000723**
MEAN	6122.113	6153.441	1624.215	1140.848	2.026898	0.229241
MCAR	6130.375	6242.212	2077.149	1400.490	2.199762	0.181669
MCAL	6113.850	6064.671	2757.584	1032.094	7.138697	**0.001161**

F - frame; R/L - right/left; MCAR/L - mean contact area, right side/left side

No differences were observed between mean contact areas as measured in the sitting position in both healthy children and children with very mild central coordination disturbance (Figure 2). The values summarizing the means of the overall contact areas are very similar and amount to 6153.44 mm^2 in the group of healthy children and 6122.11 mm^2 in the group of children with very mild CCD.

The studies assessed the mean values of contact areas for the right and the left side of the body. Children with very mild central coordination disturbances were observed to present

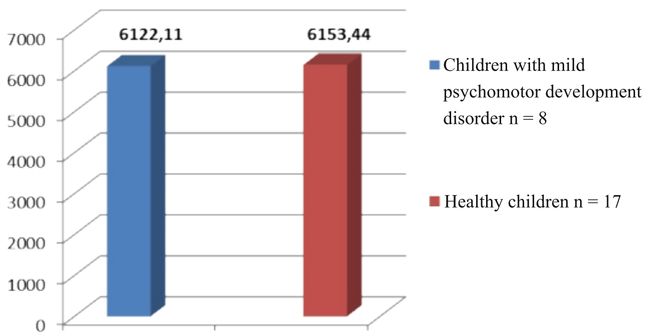


Fig. 2. Mean contact areas in sitting position

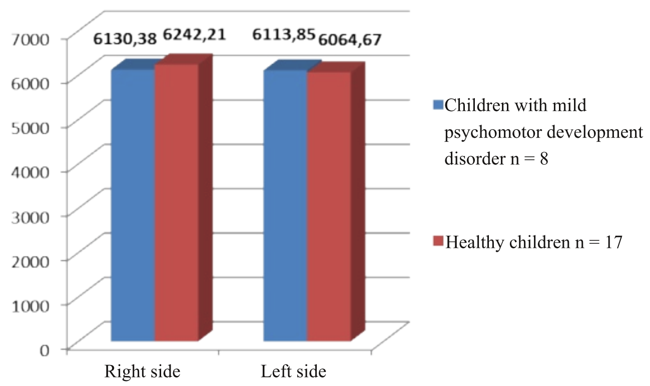
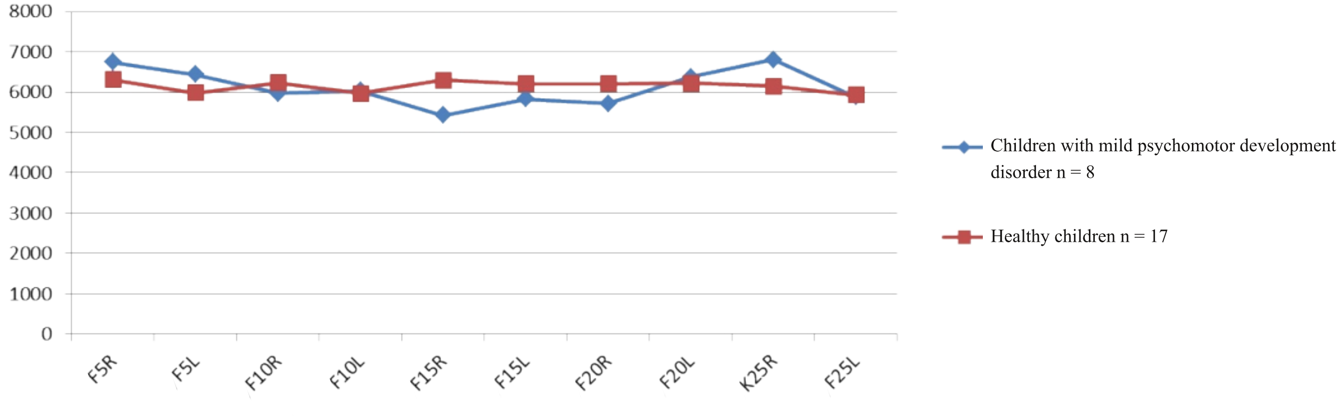


Fig. 3. Mean values of the right-side the left-side contact areas in infants in sitting position

with symmetrical distribution of contact areas on the right side and the left side. Slight deviation from a symmetric body posture was observed in healthy infants (Figure 3).

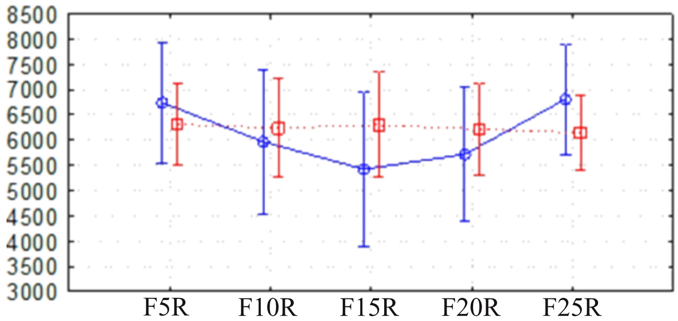
More detailed observation of subjects using the Shapiro-Wilk's test for normal distribution reveals that distribution of contact areas is not even in individual frames. We observed that healthy infants were able to maintain the normal, stable position during the entire 30-second study while lower stability was observed in children with central coordination disturbances. At the beginning of the study, one might observe the infants attempting to find the proper balanced position – frame 5. They were able to maintain stability for a short time; frames 15-20 illustrate another lean and attempt to maintain a stable posture. At the last stage of the examination, i.e. at frame 25, the infants lost their balance again. This might indicate that children with CCD adopted the normal, stable position for a short time while nearly simultaneously continuing to search for proper balance in sitting position (Figure 4).

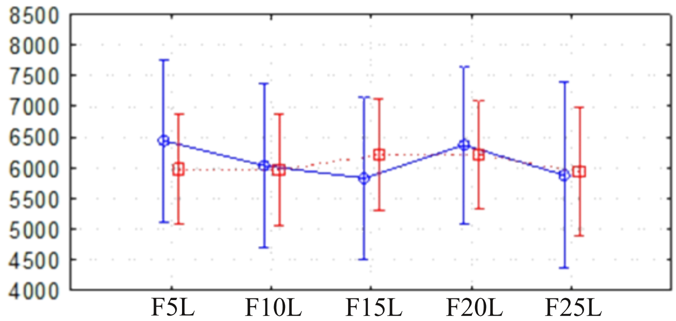


F- frame; R/L - right/left side

Fig. 4. Distribution of the right-side the left-side contact areas in individual frames

Better body stability was observed in individual frames throughout the study in healthy infants, with deviations from mean contact areas being small and oscillating within the range of 6000.00-6400.00 mm^2 (Figure 4).
Very similar values of mean contact areas were observed in individual frames in healthy infants on the right side.
Slightly more diverse values were observed on the left (Figures 5 and 6).
In the CCD group, higher variability in mean contact areas was observed on the left side as compared to the right side of the body. However, no statistical differences were observed between the right side and the left side of the body (Figure 5 and 6).





- Children with mild psychomotor development disorder n=8
- Healthy children n=17
F - frame; R/L - right/left side

Fig. 5. Mean contact areas in sitting position

Fig. 6. Mean values of the right-side the left-side contact areas in infants in sitting position

Children with very mild central coordination disturbances were characterized by the level of symmetry relative to the intergluteal cleft that was comparable to that observed in healthy infants despite the fact that larger differentiation of contact areas was observed in individual frames on both the right and the left side, probably indicative of a somewhat disturbed stability of the entire body. Of note is the fact that the very mild central coordination disturbances constituted a very small degree of central nervous system function disorders in infants; according to e.g. Vojta and Peters [16], Sadowska [17] or Banaszek [15], they did not necessarily require therapeutic intervention and are subject to spontaneous normalization. On the basis of the above, the lack of statistically significant differences between groups suggests that infants with very mild CCD be treated as healthy infants.
However, in the context of the ongoing development of the posture, be aware of this diversity because it could herald the disruption of development. This should be considered in the prevention of body posture.

Discussion and summary

Much emphasis is being laid today on early diagnostics and rehabilitation of infants. When attempting to meet the requirements of a possibly most reliable and objective diagnosis of infants, it seems necessary to pursue the highest possible objectivity of the assessment of phenomena comprising the clinical assessment of the infant's health. The study focused on the analysis of podoscopic images acquired in the sitting position.

Suchocka [18] conducted her studies in 20 infants with various types of disturbances. The children were examined two times, at ages of 2-3 and 16-18 months. The children were able to change their postural positions, raise up to the sitting position, and remain seated; half of the group started crawling on four limbs. At the age of 2-3 years, the children were referred for repeated rehabilitation due to the deficit of spontaneous ambulation. The author claimed that acquiring the quantitative psychomotor development abilities dis not warrant proper development while appropriate quality of motor patterns optimizesd the future prognosis.

Present study demonstrated differences in sitting position between healthy infants and infants with very light CCD suggest taking preventive measures within the body posture. Although the sitting position has been reached in both groups is the quality of the position in infants with ZOKN is slightly distorted and to avoid deficits / disruption in the future development of posture and locomotion, patterns of seated position shuld be correct at this stage.

As multiple changes occur during the child's development, the availability of an objective auxiliary tool would offer wider possibilities for correct diagnoses and earlier detection of such changes [19].

In the study by Nelson and Elenberg [20], no signs of the disorder were observed at age 7 in 72% of children previously diagnosed with mild diplegia.

Ellison conducted a study in a group of 999 infants, 21% of whom presented with neurological disturbances. However, the disturbances were of transient character and resolved in as many as 79% infants by the age of 15 months [21].

Postural defects are increasingly often considered a neurodevelopmental rather than only an orthopedic disorder. Having analyzed the results obtained in 86 infants with CCD, Wójtowicz et al. [12] determined that at a later age, the children presented with characteristic features of scoliosis. Postural asymmetry in infants, often due to the CCD, should therefore be subject to monitoring until the completion of growth. In the authors' opinion, central coordination disturbances in infants not subjected to rehabilitation would result in intensification and overlapping of autocompensation effects that in turn would lead to various postural defects and scolioses. According to the studies by Vojta [13] as well as Immamura, central coordination disturbances are observed in about 30% of newborns.

In addition, the authors observed limited rotation within the thoracolumbar transition in the study group, manifesting in kyphotisation of the segment in sitting position, and problems in crawling on all fours and subsequent ambulation [12].

Studies conducted by Olszewska and Hagner [22] pointed out that asymmetric position of the head affected the motor development of the children. Continuous asymmetrical positioning of the head alters

the muscle tone as well as positioning and coordination of individual body parts. Many authors emphasize that asymmetrical position of the head affects the global psychomotor development of the child.
The need for novel methods to assess the correctness of the child's development was observed in the study by Szopa et al. [2] who made use of the Sensor Mass System. The goal of this study was to assess the distribution of body mass pressures against the surface in children with motor disturbances of central nervous system origin. The study was of pilot nature.
This paper presents an attempt to objectify the infant motorics studies that give the possibility to get new information about the quality of movement patterns - a pattern of sitting position.
Czupryna et al. [3] used the PodoBaby station to assess the prone and supine positions. Two groups of children, including a group of healthy children and a group of children with motor disturbances of central nervous system origin were compared in the study. Infants with different degrees of risk of abnormal development were observed to experience more difficulties with proper distribution of weights, and slight asymmetry in the support planes was observed in both healthy and CCD infants. Despite the fact that the study assessed the prone and supine positions, observations confirmed the presence of some asymmetry in both healthy and CCD infants.
These observations support also conducted own study, which analyzed the symmetry of the contact areas in a sitting position. In many works, no detailed description of the methodology of the study and analyzed parameters making it very difficult to compare the results.
Studies conducted by Pyzio et al. [1] assessed the supine and prone positions in healthy children and in children with CCD diagnosed using a PodoBaby podoscopic station. Studies revealed differences in asymmetry as measured by the head and trunk contact areas of the right and the left side of the body between the healthy infants and the CCD infants. The analyzed asymmetry in the group of CCD infants was larger than that in healthy children.
In their next study, Pyzio-Kowalik et al. [23] used PodoBaby to assess the incidence and intensity of postural asymmetry in infants with CCD as compared to healthy infants. The relationships between the clinical diagnosis using Vojta's method based on subjective assessment of the functional of CCD infants status and the results of postural asymmetry study were determined. The study included a total of 120 infants including 60 infants with central coordination disturbances diagnosed by a neurologist, aged 3 to 6 months, and 60 healthy infants in the same age group. The results confirmed the convergence of clinical diagnosis and the asymmetry as assessed using the PodoBaby device. Statistically significant differences in postural asymmetry were observed between the healthy infants and the CCD infants [23]
The own research indicates a tendency of positional asymmetry in children with mild CCD, when tested in of sitting position. It is necessary to further analyze the asymmetry in the sitting position also in the groups of children with advanced CCD, which would be significant for diagnostic purposes and for monitoring of the therapeutic effects.
Studies conducted by Adamska et al. involved the use of a podoscope to assess the quality of the sitting position in 6 infants aged 9 months. The qualitative approach to the assessment of the sitting position as described by the authors [24] was used in this

study in the preliminary assessment of 25 infants. The findings of this study constitute a follow-up to the aforementioned research while attempting to expand the available knowledge by a quantitative assessment of the phenomenon.
The use of the PodoBaby device constitutes a continuation of the search for the methods of objective diagnosis as the study analyzes the distribution of contact areas in sitting position and compares the relevant differences in healthy and CCD children. However, it must be noted that the study was conducted in a small population and broader studies conducted in larger study groups are required for reliable conclusions to be drawn.

Conclusions

1. Sitting described the size of the of the contact areas is correct as healthy as infants and in infants with very light CCD
2. infants healthy sitting position is stable.
3. Sitting infants with very light CCD is a little less stable than in infants healthy.
4. Certain differences in the quality of infant healthy seated position relative to infants with very light CCD can provide the support of prevention activities in the field of body posture.

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