

Assessment of posture and foot video-computer monitoring dynamics in the implementation of physical therapy program for 5-6-year-old children with hip dysplasia consequences

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Abstract

Hip dysplasia is one of the most common orthopedic pathologies, the consequences of which may be manifested by functional disorders of the musculoskeletal system in preschool age, namely: postural disorders, flat feet, valgus or varus of the lower limbs. The current algorithm and physical therapy programs are not effective enough for preschoolers with the consequences of hip dysplasia, as they do not take into account the principles of patient-centered, multidisciplinary and individually-differentiated approaches. **Materials & methods:** 131 children of preschool institutions were examined with the help of video-computer monitoring of the posture "Posture-2015" and the method of photometry "BIG FOOT". **Results:** Preliminary results of posture video monitoring showed that suboptimal statics in the sagittal plane was found out in the group of children with hip dysplasia, namely: flat-concave back - in 26 children, stooped back - in 7 children, round-concave back - in 7 children, round back - in 4 children and flat back - in 1 child. According to the videogram of foot, it was determined that the percentage of children with normal values of the angle γ - without foot deformities, statistically significant ($p < 0.01$) was higher in the comparison group in 38 children (60.3%), respectively, in the group with hip dysplasia only 14 children (20.5%) were diagnosed with a normal foot. The program of physical therapy was developed, the defining features of which are systemic and complex application of kinesiotherapy, hydrokinesiotherapy, therapeutic massage, orthopedic means and preformed physical factors. As a result of the author's rehabilitation program for children 5-6 years old with the consequences of hip dysplasia implementation, the angular parameters obtained by video monitoring in the sagittal plane, indicate an improvement in posture among children of the main group - namely reduction of thoracic kyphosis and lumbar lordosis (by angles λ_1 , λ_2 , λ_3), which approached the normative values, in contrast to the results of the control group, where the dynamics was unstable. The analysis of angular and anthropomorphological indicators of the foot of children of both groups shows that the positive changes are statistically significantly more vivid in those who were engaged in the author's rehabilitation program. **Discussion:** Further study of this problem and generalization of scientific experience described in the literature may be a prerequisite for the formation of a clear and universal protocol for rehabilitation diagnosis, prognosis, identification of rehabilitation interventions and their evaluation in the process of eliminating the consequences of hip joint dysplasia and improving musculoskeletal function. **Conclusions:** The use of the developed algorithm of rehabilitation measures helped to eliminate the consequences of hip dysplasia, significantly improve the functionality of the musculoskeletal system, correct the imbalance of soft tissue components, prevent further complications, that confirms the effectiveness of the author's physical therapy program compared to the standard.

Key words: physical therapy, hip dysplasia, musculoskeletal system, children

Introduction

The problem of preserving and strengthening the health of children remains relevant in modern scientific and technical conditions, despite the constant development and improvement of the pedagogical and medical field (Afanasyev, 2017; Kashuba et al., 2017). The incidence of children of different ages over the decade has not tended to decrease, in particular the prevalence of musculoskeletal system diseases. Congenital defects of the musculoskeletal system occupy one of the first places among all congenital anomalies (Afanasyev et al., 2020; Bilinsky et al., 2019). The incidence of hip joint dysplasia (HJD) in the world is 1–7 cases per 1000 newborns (Harsanyi et al., 2020; Swarup et al., 2018). This pathology progresses and leads to negative consequences that begin to appear in preschool children due to untimely detection and treatment in early childhood (Afanasyev et al., 2020; Nosova et al., 2020; Pun, 2016).

Underdevelopment of anatomical structures, weakness of the articular ligament, that remain until the beginning of the child's walk, even with timely treatment in 5-20% of cases do not contribute to stable retention

of the femoral head in the acetabulum, and in 60% of cases instability is combined with joint damage, as well as ischemic disorders due to the use of ineffective (inadequate) orthopedic and restorative treatments (Bilinsky et al., 2019; Golka, 2017; Judd et al., 2014; Kotlarsky et al., 2015; Zinchenko, 2012).

Statistical studies of the Ministry of Health of Ukraine show that 12.5 - 20.5% of preschool children have the consequences of HJD in the form of valgus and varus deformity of the lower limbs (Zelenetsky, 2018; Zinchenko, 2012). Other clinical signs that occur as a result of HJD include restriction of movements in the hip joint, contracture of the muscles of the hip and leg, shortening of the limb, and as a consequence - a violation of the normal stereotype of walk and posture (Golka, 2017; Hertsyk, 2018; Korolkov et al., 2016; Kutsenok et al., 2005; Mavcic et al., 2008; Noordine et al., 2010).

Systematic treatment and prevention of HJD complications is a priority, and although some programs of preschool physical education provide for the use of corrective measures for children with posture disorders, flat feet, valgus and varus deformity of the limbs, but still means and methods of dysplasia complications among preschool children are not defined, and the formed approaches are not effective enough (Kashuba et al., 2019; Nosova et al., 2020). Thus, there are contradictions between the need of HJD complications treatment and the actual capabilities of the preschool institution in its implementation; the need to increase the effectiveness of physical therapy used in preschool education, and the lack of a scientifically developed system for their use in preventing complications of HJD among children.

The purpose of the work is to investigate and evaluate the indicators of video-computer monitoring of posture and foot in the process of implementing physical therapy program for children 5-6 years old with the consequences of hip dysplasia.

Materials & methods

The study was conducted on the basis of Sumy specialized preschool educational institution (kindergarten) №20 "Smile" and Sumy preschool educational institution (kindergarten) №39 "Tower". In order to study the features of the functional state of the musculoskeletal system of preschool children with the consequences of hip dysplasia, a survey of 131 children was conducted, among who two groups were formed: the first one (HJD group, n = 68) - a group of children with hip joint dysplasia (according to medical histories, medical records), who attended a specialized group of preschool education; the second group (comparison group, CG (n = 63)) - healthy children without clinical, radiological and ultrasound-confirmed signs of HJD, who attended regular group of kindergarten. The implementation and effectiveness of the developed rehabilitation program was assessed on the basis of a group of children with HJD survey (n = 68) with their subsequent division into two groups: control (n = 33), in which children were engaged in the generally accepted preschool program, and basic (n = 35), which was engaged in the author's rehabilitation program developed by us.

To record the the spatial organization of the body of the subjects characteristics, a digital camera connected to a personal computer was used using the software "Posture-2015", which was developed at the Yevminov Vertebro Health Center (Kyiv, 2015). After the photograph had been taken taken, the image of the subject was transferred to a computer software complex in Windows. The obtained images were imported into the program "Sorel Draw" for the further analysis. The method of photometry "BIG FOOT" was used to determine the functional disorders of the foot among children with HJD. Among the digitization parameters in the program "BIG FOOT" used the coordinates of 11 anthropometric points of the foot in the sagittal plane (Kashuba et al., 2018).

Windows XP and Statistica 6.0 were used for mathematical processing of digital data of research materials. The critical level of significance in testing statistical hypotheses was taken $\alpha = 0.05$ ($p < 0.05$).

Results

The usage of postural analysis helped to determine the symmetry of intersegmental relationships that characterizes posture, to identify types and degrees of posture disorders, the degree of retraction / retraction of the head, the degree of deformation of the spine and chest, to detect scoliotic deformity. Analyzing the data, it should be noted that children with hip dysplasia had a high level of posture disorders - in all surveyed groups of 68 people (100%), that indicates a significant impact of pathology on the formation of posture and suboptimal physiological curves of the spine in the subjects.

According to the results of video monitoring, it was found out that both boys and girls with HJD were dominated by disorders in the sagittal plane (66.1%). This type of disorders in the frontal plane as scoliotic posture was found out in 4.4% of surveyed children, and only among girls. Combined disorders, including scoliotic deformity and changes in the physiological curves of the spine, were observed in 29.5% of children in the HJD group.

In general, in the comparison group (CG) among the examined 38 children (60.3%) posture disorders were found out. Thus, studying the state of posture in the sagittal plane among children of CG the most common violations were in the sagittal plane - in 27 people (42.8%), the next most common combined disorders - in 7 people (11.2%), and in 4 children (6.4%) disorders in the frontal plane were found out (scoliotic posture).

Thus, both children of the HJD group and children of the comparison group had postural disorders in the sagittal plane. Therefore, during the assessment of posture disorders it was found out that children with HJD are more likely to have disorders in the sagittal plane 45 (66.1%) compared to healthy children 27 (42.8%) (Table 1).

Table 1. Assessment of the state of posture in the sagittal plane of children with HJD (n = 68) and children of the comparison group (n = 63) based on the results of video monitoring

Group	Gender, number of children	Number of cases	Type of disorder in sagittal plane, number of cases, %				
			Flat back	Stooped back	Flat concave back	Round back	Round concave back
HJD group	Boys (n=18)	14	1	3	8	1	1
	Girls (n=50)	31	-	4	18	3	6
Total number		45	1 (2,2%)	7 (15,5%)	26 (57,8%)	4 (8,9%)	7 (15,6%)
Comparison group	Boys (n=25)	10	2	6	1	1	-
	Girls (n=38)	17	3	10	4	-	-
Total number		27	5 (18,5%)	16 (59,2%)	5 (18,5%)	1 (3,8%)	-

As the children with HJD most often had a flat-concave back - 26 children (57.8%) and round-concave back - 7 children (15.5%), an increase in lumbar lordosis, it can be concluded that children with hip joint dysplasia, in addition to the typical anatomical and radiological changes in the ratio of the pelvic and femoral components of the joint, have formation of pelvic anteversion. The formation of a flat-concave back occurs due to the process of decompensation in the system "spine-pelvis", which is accompanied by a skew of the latter and an imbalance of physiological relationships in the spine.

According to the results of video monitoring of posture in the examined children of the HJD group there was a number of violations in the sagittal plane relative to the somatic frame of reference, namely: tilt of the torso forward (reduction of cervical lordosis and increase in thoracic kyphosis), as evidenced by a decrease in angles λ_1 to $52.16 \pm 6.82^\circ$ and an increase in the angle λ_2 to $37.14 \pm 3.16^\circ$ ($\bar{x} \pm S$) (which is 48.56% more than the normative values), respectively, and an increase in lumbar lordosis - the angle λ_3 decreased to $133.56 \pm 4.84^\circ$, ($\bar{x} \pm S$) (which is 21.5% less than the normative values).

Since the majority of CG children were diagnosed with such type of posture disorders as a stooped back, accordingly, there were deviations of the angular parameters determined by the sagittal profile, namely: a decrease in the average values $68.81 \pm 4.27^\circ$ ($\bar{x} \pm S$), (less by 23.5% relative to the norm) and a slight increase in the angle λ_2 to $29.21 \pm 4.32^\circ$ (which is 16.8% more than normal). The rate of lumbar lordosis on average in the group corresponded to the normative values (average values of the angle λ_3 were $154.34 \pm 3.61^\circ$), ($\bar{x} \pm S$).

The examination also revealed the presence of deformities of the lower extremities in the group of HJD, namely: in 28 identified (41.2%) identified "X" -shaped limbs (genu valgum) were identified and in 4 children (5.9%) cases "O"-shaped limbs (genu varum) were identified, in the remaining group of 36 children (52.9%) the condition of the limbs according to video monitoring was normal.

Examination of CG children revealed that 16 children (25.4%) had "X"-shaped limbs and 5 children (7.9%) "O"-shaped limbs, the remaining 42 children (66.7%) had limbs with normal indicators according to video monitoring.

Thus, a comparative analysis of the results of the assessment of the condition of the lower limbs according to video monitoring allowed to establish that valgus and varus deformities of the lower limbs were observed in both groups, in the HJD group the number of detected disorders was higher 32 (47%) cases while in the comparison group there were 21 (33,3%) children.

By the value of the angle of the longitudinal arch of the foot (γ) it was found that the percentage of children with normal values of the angle (γ), without foot deformities, that was statistically significant ($p < 0.01$) was higher in the comparison group in 38 children (60.3%), respectively, in the group of HJD only 14 children (20.5%) were diagnosed with a normal foot. Flat feet of the first grade were found out in 17 children (26.9%) of the comparison group and in 28 children (41.3%) of the HJD group. The percentage of children with flat feet of II and III degree was statistically significant ($p \leq 0.01$) and higher in the group of HJD (II degree - 22 (32.3%) and III degree - in 4 children (5.9%)), in contrast to the comparison group, there were only 8 children (12.8%) in the group with grade II flat feet, and no children with grade III contractural flat feet.

In accordance with the identified functional disorders of the musculoskeletal system, which were formed as a result of HJD, a program of physical therapy was worked out. It was aimed at eliminating the effects of hip dysplasia, improving the functionality of the musculoskeletal system, strengthening the joint and ligament

apparatus, correcting the imbalance of soft tissue components, restoring quality of life, and preventing further complications. The author's program contained preventive and rehabilitation blocks. The first unit was used during the year and included: morning hygienic gymnastics, exercise minutes and breaks, wake-up exercises, self-massage, hardening procedures (water treatments, walking barefoot, air and sun baths), psycho-emotional relief. The second block contained therapeutic gymnastics, hydrokinesiotherapy, moving games, therapeutic massage (local, general, hydromassage), physiotherapy, orthopedic devices (Rudenko, 2020).

The developed program provided for the implementation of a comprehensive approach to restore the physical and functional state of the preschool children musculoskeletal through the use of game, simulation, traction, relaxation, stretching, special power, breathing, corrective and various coordination exercises. The variability and content of the program depended on the identified disorders in children formed as a result of hip dysplasia, namely:

- for correction of violations according to the geometric profile of posture (frontal and sagittal plane): compliance with the orthopedic regime, that is provided for the elimination of asymmetric muscle traction and uneven load on different parts of the spine, creating conditions for uniform pressure on vertebral bodies. To achieve this goal, exercises were used to unload the spine, sleep on orthopedic beds, control the correct position of the child's body throughout the day, performing corrective, symmetrical and asymmetrical, strength exercises.
- for correction of valgus deformity of the foot, flat feet: exercises with elastic band Thera-band, differentiated strength exercises to develop the strength of the muscles of the foot and shin, exercises for the musculoskeletal system of the foot. The usage of strength exercises in different starting positions allowed to have a harmonious effect on a specific muscle group, and shoes with insteps were also prescribed according to the doctor's instructions. Electrostimulation of the lower extremity to strengthen the muscles of the foot and leg (5-15 minutes).
- to correct the imbalance of soft tissue components: exercises to relax and stretch the thigh adductor muscles, strengthening exercises for thigh adductors, exercises to eliminate the asymmetry of muscle tone of the flexors and extensors of the thigh, torso. Therapeutic massage of the back, pelvic girdle muscles (gluteal muscles, hip joint), thighs, legs and feet for 3 weeks (10-15 procedures) and once a quarter.
- to improve the physical qualities of children with HJD: strength, speed and strength exercises used during therapeutic gymnastics, exercise breaks and independent motor exercises, which contributed to the continuity and systematic correction of impaired musculoskeletal functions and a gradual increase in physical activity for children. Specially and methodically correctly organized moving games effectively influenced the development and strengthening of the musculoskeletal system and correction of disorders.

After the implementation of the proposed program of physical therapy, a re-examination of patients of the main group (MG) and control group (CG) was performed (after 12 months). Analysis of video monitoring of posture in the sagittal plane allows us to conclude that before the program of rehabilitation interventions according to studied indicators, children of the main and control groups had no statistically significant ($p > 0.05$) differences. According to the results of repeated examinations among children of both MG and CG, the dynamics of indicators was observed. Thus, a decrease in thoracic kyphosis was observed in the MG, as evidenced by the change in the angles λ_1 and λ_2 , and their approximation to the normative values. In MG the angle λ_1 was statistically significant ($p < 0.01$) increased from $51.16 \pm 5.87^\circ$ to $63.13 \pm 4.78^\circ$, in the CG the angle λ_1 was statistically significant ($p < 0.05$) increased from $52, 32 \pm 6.15^\circ$ to $55.21 \pm 5.36^\circ$. Despite the fact that statistically significant improvements occurred in both groups, at the stage of re-examination after the author's program of physical therapy, the difference between the angular values of λ_1 MG and CG was statistically significant ($p < 0.01$). Evaluating the results by the angle λ_2 , it was determined that in the MG there was a statistically significant ($p < 0.01$) improvement (from $37.89 \pm 4.13^\circ$ to $28.12 \pm 3.91^\circ$ (which was 87.52% of normal), in CG at the angle λ_2 the positive dynamics was not statistically significant ($p > 0.05$) (from $38.01 \pm 4.07^\circ$ to $36.26 \pm 4.21^\circ$ (which was 54.9% of normal).

The results indicate a significant improvement in the state of thoracic kyphosis in children from MG, in contrast to the results of CG. After the author's program of physical therapy implementation, these changes are statistically significant when comparing the two groups ($p \leq 0.01$). Evaluating the results by the angle λ_3 , it was determined that in the MG there was a statistically significant ($p \leq 0.01$) improvement (from $134.02 \pm 4.48^\circ$ to $149.45 \pm 6.51^\circ$, which is 87.9% of the normative values). In CG at the angle λ_3 , the positive dynamics was not statistically significant ($p > 0.05$) (from $133.93 \pm 5.12^\circ$ to $136.17 \pm 5.66^\circ$ (80.1% of normal). It indicates a significant improvement in lumbar lordosis among children with MG, in contrast to the results of CG. The difference between the results of MG and CG after the author's program of physical therapy implementation is statistically significant ($p \leq 0.01$). In the course of research, it was found out that the rate of severity of the arch of the foot improved statistically significantly among children from MG. Thus, the analysis of the dynamics of the height of the humerus of the navicular bone above the support (which characterizes the height of the longitudinal arch of the foot) indicates a statistically significant ($p < 0.05$) increase in children from MG (from

29.43 ± 2.16 to 34.16 ± 2.06, ($\bar{x} \pm S$), a similar trend was observed in the study of the dynamics of the height of the foot (determined by the height of the upper edge of the navicular bone above the support): this indicator was statistically significant ($p < 0.05$) and increased among patients from MG (from 55, 57 ± 2.66 to 63.65 ± 2.9), ($\bar{x} \pm S$)) (Table 2).

Table 2. Evaluation of angular and linear measurements of the longitudinal arch of the foot by videogram among children from MG (n = 35) and CG (n = 33) before and after the physical therapy program

Group	Statistic	Before PhTh (I)	After PhTh (II)	t- criterion of Student I-II
The height of the tubercle of the navicular bone above the support, mm				
MG, n = 35	\bar{x}	29,43	34,16	p < 0,05
	S	2,16	2,06	
	m	0,36	0,34	
CG, n = 33	\bar{x}	29,87	30,01	p > 0,05
	S	2,21	2,84	
	m	0,38	0,49	
t-criterion of Student		p > 0,05	p < 0,05	-
Height of the upper edge of the navicular bone above the support, mm				
MG, n = 35	\bar{x}	55,57	63,65	p < 0,05
	S	2,66	2,90	
	m	0,45	0,49	
CG, n = 33	\bar{x}	56,87	58,19	p > 0,05
	S	2,42	2,81	
	m	0,42	0,48	
t-criterion of Student		p > 0,05	p < 0,05	-
The angle of the arch of the foot (γ), degree				
MG, n = 35	\bar{x}	135,23	128,44	p < 0,05
	S	2,91	3,81	
	m	0,49	0,64	
CG, n = 33	\bar{x}	134,92	133,77	p > 0,05
	S	3,38	3,55	
	m	0,18	0,61	
t-criterion of Student		p > 0,05	p < 0,05	-

There were no statistically significant ($p > 0.05$) changes among CG children - the indicator of the height of the upper edge of the navicular bone tended to improve, but no statistically significant ($p > 0.05$) differences were found out (from 56.87 ± 2.42 to 58.19 ± 2.81), ($\bar{x} \pm S$)).

Discussion

Analysis of research and publications on the rehabilitation of children with hip joint dysplasia, revealed that today there is a large number of studies in terms of complex therapy (conservative and operative) of the first or second year children (Modaressi et al., 2011; Mulpuri et al. al., 2015; Vaquero-Picado et al., 2019; Yang et al., 2019; Zinchenko et al., 2018) and complications of pathology in the later period (Kotlarsky et al., 2015; Moroz, 2012; Pun, 2016). However, issues related to physical therapy of preschoolers with the consequences of hip joint dysplasia are covered partially in some publications at the level of recommended measures. Some of them are devoted to early complex therapy, which includes rehabilitation measures in the form of orthopedic means of immobilization (Freyk pillow, Pavlik's stirrup, functional splints), kinesiotherapy, therapeutic massage, physiotherapy (Afanasyev et al., 2020; Judd et al., 2014; Nosova et al., 2020; Piechocka et al., 2018; Voznytska, 2017) and surgical correction of hip dysplasia of preschool and primary school age children (Moroz, 2012; Gromov, 2015). Other authors' programs and methods of correctional and rehabilitation orientation for children with functional disorders of HJD in preschool educational institutions may be similar to HJD of older children (Modaressi et al., 2011; Moroz, 2012). The study conducted at the stage of the observational experiment revealed the main consequences caused by early hip joint dysplasia among children and revealed differences in the musculoskeletal system compared to healthy children, which became the basis for the construction of methods of rehabilitation using various means of rehabilitation. According to the results of video monitoring of posture, it was found out that children with HJD are more likely to have postural disorders in the sagittal plane 45 children

(66.1%) compared to 27 healthy children (42.8%). In the group of children with hip joint dysplasia, the statics in the sagittal plane is non-optimal: children with HJD have such type of posture disorders as flat-concave back, which was found out in 26 subjects (57.8%), stooped back was diagnosed in 7 children (15, 5%), round-concave back - in 7 children (15.6%), round back - in 4 (8.9%) and flat back in 1 child (2.2%).

Video monitoring of the condition of feet, which determined the angle of the longitudinal arch of the foot (γ), revealed children with the consequences of HJD: flat feet of the I degree - in 28 children (41.3%), II degree - in 22 children (32.3%) and III degree - in 4 children (5.9%), in contrast to the comparison group, only 8 (12.8%) children of the group had flat feet of the II degree.

The average value of the vault angle was statistically more significant ($p \leq 0.01$) in the group of children with HJD 135.23 ± 5.91 ($\bar{x} \pm S$) than in the comparison group 128.94 ± 4.99 ($\bar{x} \pm S$), which confirms the fact that children with HJD are more prone to the development of foot deformities. The results of our research supplement theoretical data on the occurrence of hip dysplasia due to impaired metabolism of certain estrogen hormones, which cause a selective decrease in the elasticity of connective tissue elements of the body. Thus, patients with HJD have other deformities associated with relaxation of tendon-ligament and joint elements (flat, flat-valgus feet, valgus deformities of limbs) are more common (Dezateux et al., 2007; Holroyd et al., 2009).

The results of the study confirmed and supplemented the data of (Nosova et al., 2020) on the predominance of the frequency of postural disorders in the sagittal plane and flat feet among children with HJD compared to healthy children according to the results of video monitoring. The results of our work significantly supplemented the data of the authors (Kashuba et al., 2017–2019; Nosova et al., 2020) on the peculiarities of the relationship between quantitative biostatic indicators of the biogeometric profile of posture and support-spring function of the feet of 5-6 years old children with unfixed violations of the musculoskeletal system, namely: the severity and plane of postural disorders, features of varus or valgus installations of the lower limbs and the shape of the flat feet, the patterns that were found out between them.

New data on the specifics of the formation of causal mechanisms and manifestations of functional disorders of the musculoskeletal system due to dysplasia of the hip joints of children 5-6 years old were obtained. Data (Afanasyev et al., 2020; Nosova et al., 2020; Judd et al., 2014; Piechocka et al., 2018; Vaquero-Picado et al., 2019; Yang et al., 2019; Zinchenko et al., 2018) on the positive effect of exercise, therapeutic massage, natural and preformed physical factors in the rehabilitation of the effects of hip dysplasia were confirmed. Data (Cherednichenko, 2016) on the positive effect of mobile games on the formation of the correct arch of the foot have been supplemented. Thus, the assessment of angular characteristics reflecting the functional state of the foot, namely the angle of the arch of the foot (γ), of children with hip dysplasia after the introduction of physical therapy showed that a statistically significant ($p < 0.05$) improvement occurred in CG (with $135.23 \pm 2.91^\circ$ to $128.44 \pm 3.81^\circ$), ($\bar{x} \pm S$), in contrast to the results of CG, where there was a positive dynamics, but statistically significant ($p > 0.05$) differences compared with the primary data is not recorded (from $134.92 \pm 3.38^\circ$ to $133.77 \pm 3.55^\circ$), ($\bar{x} \pm S$)).

For the first time, a comprehensive program of physical therapy for children 5-6 years old with the consequences of hip joint dysplasia in a preschool educational institution was scientifically substantiated, developed and tested (Hertsyk, 2018). The proposed author's rehabilitation program provided implementation of patient-centered and multidisciplinary approaches. Under the influence of its components, more positive quantitative changes in the functional state of posture and foot were registered by video monitoring, compared to the effect of conventional programs.

Conclusions

Preliminary results of video monitoring of posture showed that in the group of children with HJD suboptimal statics in the sagittal plane was found out, namely: flat-concave back - in 26 children, stooped back - in 7 children, round-concave back - in 7 children, round back - in 4 children and flat back - in 1. Thus, in addition to the typical anatomical and radiological changes in the ratio of pelvic and femoral components of the hip, characteristic of children with HJD, there is also formation of pelvic anteversion, which is reflected in the formation of lumbar hyperlordosis (flat-concave) and (round-concave back). According to the videogram of the foot, it was determined that the percentage of children with normal values of the angle γ - without foot deformities, statistically significant ($p < 0.01$) was higher in CG in 38 children (60.3%), respectively, in the group of HJD only 14 children (20.5%) were diagnosed with a normal foot.

In accordance with the identified functional disorders of the musculoskeletal system, which formed as a result of HJD in children, a program of physical therapy was developed, the defining features of which are systemic and complex application of kinesiotherapy, hydrokinesiotherapy, therapeutic massage, orthopedic devices, hydrotherapy and preforms.

As a result of the author's program of physical therapy for children 5-6 years old with the consequences of hip dysplasia, the angular parameters obtained by video monitoring in the sagittal plane, indicate an improvement in posture in children of the MG - namely, a reduction in thoracic kyphosis and lumbar lordosis (according to the results angles λ_1 , λ_2 , λ_3), which approached the normative values, in contrast to the results of

CG, where the dynamics was unstable. Evaluation of the angular characteristics that reflect the functional state of the foot, namely the angle of the arch of the foot (γ) in children with HJD after the implementation of the rehabilitation program showed that a statistically significant ($p < 0.05$) improvement occurred in the MG (from $135.23 \pm 2.91^\circ$ to $128.44 \pm 3.81^\circ$, ($\bar{x} \pm S$)), in contrast to the results of CG, where there was positive dynamics, but statistically significant ($p > 0.05$) differences compared with the initial data was not recorded (from $134.92 \pm 3.38^\circ$ to $133.77 \pm 3.55^\circ$, ($\bar{x} \pm S$)). Thus, the analysis of angular and anthropomorphological indicators of the foot of children of MG and CG group shows that the positive changes are statistically significantly more pronounced in children who were engaged in the author's rehabilitation program.

Conflicts of interest

The authors declare that there is no conflict of interests.

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