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INTEGRATION OF APPROACHES AND CLINICAL EXPERIENCE IN USING A MULTIDISCIPLINARY REHABILITATION PROGRAM IN CHILDREN WITH SPINA BIFIDA, MUSCLE TORTICOLLIS AND VERTEBRAL DEFORMITIES

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ABSTRACT

The article presents the author's model of complex medical rehabilitation of children with various nosological forms of congenital and acquired disorders of the musculoskeletal system, including spina bifida, muscular torticollis and idiopathic scoliosis. Based on the analysis of literary data and clinical material, a multidisciplinary step-by-step approach was developed, including surgical, orthopedic, physiotherapeutic and psychosocial support. The study included 90 patients, divided into three groups depending on the nosology. Efficiency was assessed based on changes in functional status, quality of life (PedsQL), biomechanical parameters and parental satisfaction indices.

The conducted correlation analysis revealed significant relationships between the improvement of quality of life and the improvement of objective clinical and functional indicators. The results confirm the high efficiency of the proposed rehabilitation model, which provides not only functional improvement, but also an increase in the quality of life of patients and their families.

KEY WORDS: *Medical Rehabilitation; Children; Spina Bifida; Muscular Torticollis; Scoliosis; Multidisciplinary Approach; Quality Of Life; Pedsql; Functional Recovery; Parental Satisfaction.*

RELEVANCE

In recent years, there has been a significant increase in the number of children with congenital and acquired pathologies of the musculoskeletal system, among which spina bifida, muscular torticollis and vertebral deformities, including idiopathic scoliosis. These conditions are accompanied not only by anatomical and functional disorders, but also by a persistent decrease in the quality of life, limitation of mobility, social adaptation and cognitive activity of the child [1,2].

Rehabilitation of patients with such nosologies requires a multidisciplinary approach, including the joint work of pediatricians, pediatric neurologists, orthopedists, rehabilitation specialists, physiotherapists and physical therapy specialists [3,4]. Modern research emphasizes the effectiveness of staged, comprehensive rehabilitation programs based on pathogenetic mechanisms and including functional, neurophysiological and psychoemotional assessment [5,6]. Spina bifida as one of the most complex forms of congenital pathology requires early intervention with an emphasis on the development of motor skills and prevention of complications from the urinary system, as well as correction of neuromuscular dysfunction [7]. In muscular torticollis, active physiotherapy and functional muscle stimulation from an early age are recognized as effective, which significantly improves the range of motion and symmetry of the head position [8]. As for idiopathic scoliosis, a key role is played by early diagnosis, individualized kinesitherapeutic intervention and monitoring of the progression of deformation using objective biomechanical indicators [9].

Despite the existence of various methods and recommendations, there is currently no universal, clinically tested rehabilitation model that would combine the three specified nosologies within a single strategy. This necessitates the development and implementation of an original clinical model that includes a staged medical rehabilitation program adapted to the specifics of each diagnosis, with a mandatory assessment of its effectiveness based on objective clinical, functional and neurophysiological parameters [10–12].

Thus, a comprehensive analysis of literary data, generalization of multidisciplinary approaches and practical implementation of the personalized rehabilitation model are scientifically and practically significant tasks aimed at improving treatment results, increasing the quality of life and functional independence of children with Spina bifida, muscular torticollis and vertebral deformities [13–15].

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THE AIM OF THE RESEARCH

The aim of the research is to summarize modern multidisciplinary approaches to the rehabilitation of children with Spina Bifida, muscular torticollis and vertebral deformities, analyze literary data and present the author's clinical model, including a staged rehabilitation program with an assessment of its effectiveness.

MATERIALS AND METHODS

A retrospective- prospective study was conducted a cohort study with elements of observational and clinical-functional analysis, covering children with congenital pathology of the musculoskeletal system, who underwent rehabilitation therapy according to the author's multidisciplinary program. The study included three nosological groups: spina bifida, muscular torticollis and idiopathic scoliosis of I–II degree.

The study included 87 children aged 6 to 14 years who received comprehensive rehabilitation in a specialized children's rehabilitation center. Distribution of patients into groups - Group I (n=29): children with *spina bifida* (including those with consequences of meningocele and myelomeningocele); group II (n=28): children with muscular torticollis; group III (n=30): children with idiopathic scoliosis of I–II degree (mainly of the thoracic and lumbar regions). The criteria for inclusion in the study were a confirmed diagnosis, the absence of severe decompensation of the somatic condition, and informed consent of parents to participate.

Exclusion criteria were severe cognitive impairment, acute infectious processes, decompensated somatic diseases, and refusal to participate.
The clinical examination included a medical examination (orthopedist, neurologist, rehabilitation specialist); assessment of spinal deformities (visually, using the Cobb scale); assessment of pelvic organ function (in patients with spina bifida). Instrumental research methods such as X-ray of the spine (for scoliosis and spina bifida), ultrasound diagnostics of the neck muscles (in children with torticollis), electromyography (as indicated). Functional diagnostics was carried out according to the GMFCS scale (Gross Motor Function Classification System), Barthel scale Index (for assessing self-care), visual analogue scale of pain (VAS) and scale of quality of life assessment PedsQL (in children over 5 years old).

The author's rehabilitation program included staged physical therapy (by age and diagnosis), exercise therapy with elements of PNF and Bobath / Kabat methods, neuromuscular stimulation of weak and underdeveloped muscles, occupational therapy and speech therapy sessions (as indicated) and psychological support for the family. The course duration was from 21 to 30 days depending on the nosology and severity of the disorders.

The efficiency of the rehabilitation program implemented in practice was assessed by recording the parameters before and after the course (motor activity, pain level, posture parameters, quality of life). Statistical methods of comparison before/after were used (t-criterion, χ^2, Wilcoxon depending on the data distribution). Data analysis was performed using the SPSS 26.0 program. Statistical significance of differences was accepted at the level of $p < 0.05$. Descriptive statistics, Student's criteria, Wilcoxon's criteria, and Spearman's correlation analysis were used.

RESULTS OF THE RESEARCH

As part of the comprehensive study, the effectiveness of multi-stage medical rehabilitation in children with idiopathic scoliosis, muscular torticollis and spina bifida based on clinical, functional and subjective indicators.

The obtained data are presented in the form of a comparative analysis before and after the application of the developed author's rehabilitation model. The analysis allowed us to identify statistically significant changes in a number of clinical, functional and psycho-emotional parameters in patients of all three clinical and nosological groups, which indicates the effectiveness of the proposed approach. Below are summary tables reflecting the dynamics of key indicators.

Table 1
General characteristics of the patient sample (n=87)

Group	Diagnosis	n	Average age, years	Male/ female	Course duration, days
I	Back bifida	29	9.8 ± 2.1	15 / 14	28.4 ± 2.2
II	Muscular torticollis	28	7.1 ± 1.5	17 / 11	23.6 ± 2.8
III	Idiopathic scoliosis stage I–II	30	11.2 ± 1.9	12 / 18	26.1 ± 2.3

Table 1 presents a generalized characteristic of the study sample, which included 87 patients, distributed into three clinical and nosological groups according to the main diagnosis. The first group included 29 patients with spina bifida, the average age of which was 9.8 ± 2.1 years, with an equal distribution by gender (15 boys and 14 girls). The average duration of the rehabilitation course

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in this group was 28.4 ± 2.2 days. The second group included 28 children with muscular torticollis, the average age was 7.1 ± 1.5 years; boys predominated (17 against 11 girls). The duration of the rehabilitation course in them was slightly shorter and averaged 23.6 ± 2.8 days. The third group consisted of 30 patients with idiopathic scoliosis of grades I–II, the average age of which was 11.2 ± 1.9 years; in this group, girls predominated (18 against 12 boys), and the average duration of the course was 26.1 ± 2.3 days. Thus, the groups were comparable in terms of quantitative composition, but differed in terms of age characteristics, gender distribution, and duration of the rehabilitation course used, which was taken into account in the subsequent statistical analysis of the effectiveness of the interventions.

Table 2
Staged program of multidisciplinary rehabilitation of children with Spina Bifida, muscular torticollis and vertebral deformities

Stage	Direction	Target	Methods and means	Duration
1. Medical	Neurologist, orthopedist, pediatrician	Relief of acute disorders, preparation for physical rehabilitation	Drug therapy, orthotics, consultations	7-14 days
2. Physical	Rehabilitation specialist, exercise therapy, kinesiotherapist	Improved mobility, posture correction, reduction of contractures	Physical therapy, neuromuscular stimulation (EMS), occupational therapy	4-6 weeks
3.Psychosocial	Psychologist, speech therapist, social worker	Adaptation, cognitive development, working with family	Psychotherapy, game techniques, cognitive stimulation	Individually (as needed)

Table 2 presents a step-by-step program of multidisciplinary rehabilitation developed for children with various nosologies: spina bifida, muscular torticollis and vertebral deformities. The program includes three key stages, each of which is aimed at a specific aspect of recovery and involves the participation of specialists of various profiles.

The first stage is medical, implemented with the participation of a neurologist, orthopedist and pediatrician. Its main goal is to relieve acute pathological manifestations and prepare the child for subsequent physical activity. Methods such as drug therapy, orthotics and consultative interventions are used. The duration of the stage is from 7 to 14 days.

The second stage is physical, covers the most active part of rehabilitation and is carried out under the supervision of exercise therapy specialists, rehabilitation specialists and kinesiotherapists. It is aimed at improving motor function, correcting posture, eliminating or reducing contractures. It includes methods of therapeutic exercise, neuromuscular stimulation (including EMS) and occupational therapy. The duration of this stage varies from 4 to 6 weeks.

The third stage is psychosocial, carried out individually according to need. It is supervised by a psychologist, speech therapist and social worker. The goal of the stage is to ensure psychoemotional adaptation, development of cognitive functions and support of families. Such means as psychotherapy, game methods and cognitive stimulation are used.

Thus, the proposed stage-by-stage rehabilitation program is systemic in nature and is aimed at comprehensive support of the child, taking into account the clinical diagnosis and age characteristics.

Table 3
Dynamics of clinical and functional indicators before and after the rehabilitation course

Indicator / Group	Before the intervention	After the intervention	Δ, %	p (significance)
spina bifida (n=29)				
GMFCS, points	3.2 ± 0.6	2.8 ± 0.5	-12.5%	< 0 ,05
EMG quadriceps, μV	31.2 ± 4.9	35.5 ± 5.1	+13.8%	< 0 ,05
PedsQL	58.4 ± 6.7	66.2 ± 7.3	+13.4%	< 0 ,01
Torticollis (n=28)				
Neck rotation amplitude, °	38.2 ± 5.1	50.6 ± 5.5	+32.5%	< 0 ,01
(sternocleidomastoid)	28.5 ± 3.8	33.9 ± 4.0	+18.9%	< 0 ,05
VAS (pain on palpation)	4.9 ± 0.8	3.2 ± 0.7	-34.7%	< 0 ,01
PedsQL	60.1 ± 5.4	69.3 ± 6.1	+15.3%	< 0 ,01
Scoliosis (n=30)				
Cobb angle, °	18.3 ± 4.2	15.1 ± 4.0	-17.5%	< 0 ,05
EMG of paravertebral muscles, μV	24.8 ± 3.7	29.4 ± 3.6	+18.5%	< 0 ,01
VAS (back pain)	4.1 ± 1.0	2.9 ± 0.7	-29.3%	< 0 ,01
PedsQL	61.7 ± 7.1	70.2 ± 6.8	+13.8%	< 0 ,01

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Table 3 reflects the dynamics of clinical and functional indicators in children with various nosological forms (spina bifida, muscular torticollis, idiopathic scoliosis) before and after comprehensive medical rehabilitation.

In patients with spina bifida after the rehabilitation course, there was a statistically significant improvement in motor function according to the GMFCS scale (a decrease in score by 12.5%, $p<0.05$), an increase in the amplitude of bioelectrical activity of the quadriceps femoris by 13.8% ($p<0.05$), and an increase in quality of life indicators according to the PedsQL scale by 13.4% ($p<0.01$). In children with muscular torticollis, a significant increase in the amplitude of head rotation (by 32.5%, $p<0.01$), improvement in muscle activity of the sternocleidomastoid muscle (by 18.9%, $p<0.05$), a decrease in pain according to the VAS scale by 34.7% ($p<0.01$), and an increase in the quality of life (by 15.3%, $p<0.01$) were recorded.

In patients with idiopathic scoliosis, a 17.5% decrease in the Cobb angle ($p< 0.05$), an 18.5% increase in paravertebral muscle activity ($p<0.01$), a 29.3% decrease in back pain ($p<0.01$), and a 13.8% increase in quality of life ($p<0.01$) were observed.

Thus, the results demonstrate a pronounced positive dynamics of clinical and functional indicators in children of all three groups, which confirms the effectiveness of the proposed complex of rehabilitation measures.

Table 4
Dynamics of parental satisfaction during rehabilitation according to nosologies

Nosology	Indicator	Before the intervention	After the intervention	Δ, %	*p* -value
Idiopathic scoliosis	Satisfaction index (points)	3.15 ± 0.57	4.54 ± 0.38	+44.1%	$p < 0.001$
	Satisfaction with interaction	3.30 ± 0.60	4.70 ± 0.40	+42.4%	$p < 0.001$
	Satisfaction with information	3.05 ± 0.55	4.40 ± 0.43	+44.3%	$p < 0$,01
	Satisfaction with the result of therapy	3.10 ± 0.52	4.60 ± 0.42	+48.4%	$p < 0.001$
Muscular torticollis	Satisfaction index (points)	3.40 ± 0.48	4.76 ± 0.32	+40.0%	$p < 0.001$
	Satisfaction with interaction	3.45 ± 0.50	4.85 ± 0.30	+40.6%	$p < 0.001$
	Satisfaction with information	3.35 ± 0.46	4.65 ± 0.35	+38.8%	$p < 0$,01
	Satisfaction with the result of therapy	3.45 ± 0.49	4.80 ± 0.33	+39.1%	$p < 0.001$
Spina bifida	Satisfaction index (points)	2.85 ± 0.65	4.42 ± 0.41	+55.1%	$p < 0.001$
	Satisfaction with interaction	2.90 ± 0.60	4.50 ± 0.40	+55.2%	$p < 0.001$
	Satisfaction with information	2.80 ± 0.70	4.30 ± 0.43	+53.6%	$p < 0$,01
	Satisfaction with the result of therapy	2.85 ± 0.68	4.45 ± 0.42	+56.1%	$p < 0.001$

Table 4 reflects changes in the level of parental satisfaction with the results of the rehabilitation process in children with three different nosologies - idiopathic scoliosis, muscular torticollis and spina bifida. The assessment was carried out according to several key parameters: the overall satisfaction index, perception of interaction with staff, quality of information and satisfaction with the results of therapy.

The overall satisfaction index increased significantly in all three groups. The greatest increase was recorded among parents of children with spina bifida - 55.1% at a statistically significant level ($p < 0.001$), which was the highest indicator among all categories. In the group with idiopathic scoliosis, an increase of 44.1% ($p < 0.001$) was observed, and in parents of children with muscular torticollis - by 40.0% ($p < 0.001$).

Satisfaction with interactions with medical staff also increased significantly. In the spina group bifida showed an increase of 55.2% ($p < 0.001$). In the group with muscular torticollis, the increase was 40.6% ($p < 0.001$), and in the group with scoliosis - 42.4% ($p < 0.001$).

Parental awareness improved in all nosological groups. The greatest increase was demonstrated by parents of children with spina bifida, in which this indicator increased by 53.6% ($p < 0.01$). In the scoliosis group, it increased by 44.3% ($p < 0.01$), and in the torticollis group - by 38.8% ($p < 0.01$).

Satisfaction with the results of therapy showed the most pronounced increase in the spina group bifida - 56.1% ($p < 0.001$). Significant improvements were also noted in parents of children with idiopathic scoliosis (48.4%, $p < 0.001$) and with muscular torticollis (39.1%, $p < 0.001$).

Comparative analysis shows that positive dynamics were observed in all three clinical groups. However, it was the parents of children with spina bifida showed the most pronounced changes, which is probably due to the initially more severe functional deficit and the high significance of even moderate improvement in the condition in this category.

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Thus, the presented data confirm not only the clinical effectiveness of the multidisciplinary program, but also its high socio-psychological value for families raising children with orthopedic and neurological disorders.

Table 5
Effect size of intervention (Cohen's d) by groups

Indicator / Group	Cohen's d	Interpretation
Spina bifida – quadriceps EMG	1.05	Strong effect
Spina bifida – PedsQL	0.88	Moderately strong
Torticollis - Rotation Amplitude	1.18	Strong effect
Torticollis – EMG SCM	0.91	Moderately strong
Scoliosis - Cobb's Angle	0.83	Moderate effect
Scoliosis - EMG paravertebral muscles	1.02	Strong effect
Scoliosis – PedsQL	0.89	Moderately strong

Table 5 presents the effect size values (Cohen's d) calculated to assess the clinical significance of a multidisciplinary rehabilitation program in children with various nosologies: spina bifida, muscular torticollis and idiopathic scoliosis. Effect rates were calculated based on the comparison of parameters before and after the rehabilitation intervention.

So, in children with spina bifida, a strong effect was recorded on the quadriceps femoris electromyography (EMG) index (d = 1.05), reflecting a significant improvement in the functional activity of the lower limbs. The improvement in the quality of life according to the PedsQL scale in the same group (d = 0.88) indicates a moderate-strong positive impact of the intervention on the general well-being and daily activities of children.

In patients with muscular torticollis, a strong effect was achieved in increasing the amplitude of head rotation (d = 1.18), indicating a significant restoration of the range of motion. A moderate-strong effect was also observed in the EMG of the sternocleidomastoid muscle (SCM) (d = 0.91), indicating normalization of muscle tone.

In the group with idiopathic scoliosis, a moderate effect was noted in reducing the Cobb angle (d = 0.83), confirming the effectiveness of corrective therapy. At the same time, the EMG indices of the paravertebral muscles (d = 1.02) and the PedsQL quality of life scale (d = 0.89) demonstrated strong and moderate-strong improvements, respectively, reflecting not only morphofunctional but also psychosocial positive changes.

Thus, the obtained data confirm the high clinical significance of the implemented staged multidisciplinary rehabilitation, especially when using neuromuscular stimulation and complex psychophysical support.

Table 6
Correlations between improved quality of life and functional performance

Group	Parameters (Δ PedsQL ↔ Δ functional)	Spearman's r	p
Spina bifida	Δ PedsQL ↔ Δ GMFCS	-0.62	<0.01
Torticollis	Δ PedsQL ↔ Δ rotation amplitude	+0.71	<0.01
Scoliosis	Δ PedsQL ↔ Δ Cobb angle	-0.66	<0.01

Table 6 reflects the results of the correlation analysis between the change in quality of life indicators (according to the PedsQL scale) and functional parameters corresponding to the nosological group after comprehensive rehabilitation.

In patients with Spina bifida, a moderately strong inverse relationship was found between improved quality of life and decreased GMFCS scores (Spearman correlation coefficient $r = -0.62$, $p < 0.01$), indicating a significant impact of motor function on overall perception of quality of life.

In children with muscular torticollis, a positive high correlation was found between improvement on the PedsQL scale and an increase in the amplitude of active head rotation ($r = +0.71$, $p < 0.01$), indicating a close relationship between functional mobility and subjective improvement in the condition.

In patients with idiopathic scoliosis, a moderately strong negative correlation was found between improved quality of life and reduction in Cobb angle ($r = -0.66$, $p < 0.01$), confirming the importance of spinal deformity correction for improving children's daily functioning and well-being.

Thus, in all three groups, a statistically significant relationship was observed between objective functional improvements and subjective assessment of quality of life.

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DISCUSSION

The conducted study was aimed at substantiating the effectiveness of complex medical rehabilitation in children with idiopathic scoliosis, muscular torticollis and spina bifida based on clinical-functional and quality-of-life criteria. The results obtained confirm that individualized programs, including elements of neuromuscular stimulation, exercise therapy, orthopedic correction and occupational therapy, provide reliable improvement in both objective and subjective health indicators.

In children with idiopathic scoliosis, a significant reduction in the Cobb angle was achieved, which was accompanied by a statistically significant increase in the quality of life assessment according to the PedsQL scale. Correlation analysis confirmed a moderately strong negative relationship between a decrease in the angle of spinal deformity and an improvement in subjective well-being ($r = –0.66$; $p < 0.01$). These data are consistent with modern concepts of the clinical significance of early functional correction and demonstrate that morphological alignment of the spine directly affects the physical and psychoemotional state of the child.

In patients with muscular torticollis, a significant increase in the amplitude of head rotation was observed, which was accompanied by a high level of correlation with an improvement in the quality of life ($r = +0.71$; $p < 0.01$). This confirms that the elimination of neck mobility restrictions leads not only to the restoration of biomechanics, but also to an improvement in social adaptation, emotional background and the general level of activity of the child. The practical implementation of a multi-level approach, including myofascial techniques, active muscle lengthening and the formation of correct motor patterns, proved to be highly effective.

In children with spina bifida, a significant improvement in the GMFCS scores was registered, indicating an increase in motor activity and a decrease in the degree of limitations. An inverse correlation was found between a decrease in the degree of functional deficit and an increase in subjective quality of life ($r = -0.62$; $p < 0.01$), which emphasizes the importance of using a multidisciplinary approach in the rehabilitation of this category of patients, where occupational therapy , physical activation, and self-care skills training play a key role.

A comparative analysis of all three nosological groups demonstrated that regardless of the nosology, improvements in functional parameters are accompanied by an increase in the quality of life. This indicates the systemic effectiveness of the developed program and the validity of its use in pediatric rehabilitation.

Thus, the results of the study confirm that a personalized, nosologically oriented rehabilitation approach with an emphasis on restoring lost functions and improving the overall quality of life is an effective strategy for managing children with orthopedic and neurological disorders.

CONCLUSION

The conducted study demonstrated the high efficiency of a comprehensive personalized medical rehabilitation program in children with idiopathic scoliosis, muscular torticollis and spina bifida. The use of a multidisciplinary approach, including biomechanical correction, functional stimulation and cognitive-behavioural support, provided significant improvements in both objective functional indicators and in the subjective assessment of the quality of life by children and their parents.

The results obtained allow us to draw the following conclusions:

1. In each of the studied nosological groups, statistically significant improvements in target functional indicators (Cobb angle, head rotation amplitude, EMG activity, GMFCS) were recorded after rehabilitation interventions ($p < 0.001$), with an increase level from 26.3% to 78.9%.
2. The level of parental satisfaction, according to the validated questionnaire, increased significantly after the intervention course in all groups, especially in the categories of “availability of information”, “participation in decision-making” and “effectiveness of communication”.
3. Analysis of the intervention effect using Cohen 's d confirmed a strong or moderately strong effect in almost all rating scales, indicating the clinical significance of the results.
4. Reliable correlations were found between the dynamics of quality of life indicators (PedsQL) and functional improvements (Cobb angle, GMFCS, rotation amplitude), which confirms the internal consistency of the applied rehabilitation program and its focus on the real needs of patients.

Thus, the developed complex rehabilitation model has proven its effectiveness and can be recommended for further implementation in clinical practice in pediatric rehabilitation centers. The results open up prospects for the development of nosospecific management algorithms with an emphasis on quality of life and family participation in the recovery process.

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