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## PHYSICAL THERAPY FOR HEADACHE WITH CERVICAL SPINE INSTABILITY IN CHILDREN

O. V. Gorsha<sup>1</sup>, N. V. Korolenko<sup>2</sup>, M. V. Shkolna<sup>2</sup>, V. I. Gorsha<sup>1</sup>

<sup>1</sup>International Humanitarian University, Odesa, Ukraine, Odessa

<sup>2</sup>The Odessa Regional Charitable Fund for Rehabilitation of Disabled Children  
“Maybutnie”, Odessa

### Abstract

The aim of the study was to investigate the effects of Kinesio Taping and therapeutic exercises on the clinical condition and hemodynamics of the vessels of the vertebrobasilar basin in children of primary school age with headache syndrome on the background of instability of the cervical spine. The study showed that the comprehensive use of these children in these methods of physical therapy has reduced the manifestation of pain (reduction of the frequency and intensity of headache), optimize the hemodynamics (blood flow, elastic properties of blood vessels, response to negative extravasal effects of the surrounding structures, venous outflow). The studied methods do not allow for a long time (6 months) to keep all the achieved clinical and functional results at the same level, although mostly they remain better than before treatment ( $p < 0.05$ ).

**Key words:** children; headache; instability of the cervical spine; hemodynamics of the vessels of the vertebrobasilar basin; physical therapy; Kinesio Taping;

## **therapeutic exercises.**

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**Introduction:** Despite a great number of headache (HA) problem researches, the age aspects of cephalgia remain the least investigated. The cervicogenic cephalgic syndrome in children, in particular, may be one of the leading manifestations of dysplastic instability of the cervical spine (ICS) [3]. Meanwhile, the number of children and adolescents suffering from HA is steady increasing, according to scattered data, more than 40%. While the deterioration in the quality of life of patients with cervicogenic HA can be compared with that of migraine and HA of tension [3, 10].

Pathology of the cervical spine, including manifestations of instability of the craniovertebral motor segment, as well as lower vertebrae on the background of relaxation of ligaments in childhood is considered one of the main causes of vertebro-basilar insufficiency (VBI) in children [2].

Analysis of the publications of most researchers on the problem of pain syndromes of a vertebrogenic nature showed that it is advisable to combine non-drug and drug effects of treatment [1, 11-15]. But the main thesis is that a symptomatic approach to drug analgesia of HA is often unable to solve this problem of cervicogenic nature. Non-drug methods are mainly based on a combination of three blocks: kinesiotherapy; biomechanical correction of the spine; acupuncture and physiotherapy [11-13]. However, ICS, children's age under 12 years, and conducted therapy at the background of the pain sharply limit treatment effects on HA syndrome in primary school children.

An alternative approach that can be used to treat HA in children with vertebro-basilar dysfunction on the background of dysplasia of connective tissue (DCT) is the method of Kinesio Taping (KTP) of the cervical region muscles [1, 5, 11-13], as well as in the works of foreign researchers [14, 15]. Also, the undoubted advantage of this method is the preservation of the active lifestyle of patients with soft fixation of the musculofascial segment (which is important with ICS) against the background of reflexogenic stimulation with tapes of certain spine or limbs segments [5].

So, the importance of the study of pathogenetically determined aspects of cervicogenic HA therapy in children is explained by its prevalence, the etiopathogenetic mechanisms complexity, age restrictions of HA drug treatment in the pediatric group and undetected

algorithms and methodological approaches to physiotherapy (PhT) of this pathology.

**The purpose** of this research was to investigate the effects of KTP and therapeutic exercises on the clinical condition and hemodynamics of the vessels of the vertebrobasilar basin in primary school children with HA syndrome on the background of ICS.

**Material and methods:** An assessment of the effectiveness of Kinesio Taping (KTP) and therapeutic exercises (ThE) in 60 children of primary school age (6–11 years) with ICS, who had a headache, which, after exclusion of other pathology, we interpreted as “vertebrogenic” or “cervicogenic” was conducted at the non-hospital setting “The Odessa Regional Charitable Fund for Rehabilitation of Disabled Children “Maybutnie”, Odessa”. Also, the criterion for involving children in the study was to obtain the informed consent of children and their parents/guardians.

Exclusion criteria from the experiment: other or unexplained nature of the headache; comorbidities at decompensation stage; individual sensitivity in the form of allergic reactions; intellectual disabilities.

The children had the pathology during the period from two months to two years. Examinations were performed in dynamics: before the course of treatment when the child visited the medical care unit, after the PhT course, and in one and six months (in order to study the long-term results of treatment). The data of the initial examination of patients were compared with the control group — 30 healthy children of the similar age and sex.

During the month, the patients of the main group received PhT in an outpatient setting, which consisted in a comprehensive use of KTP and therapeutic exercises. KTP of the cervical zone of sick children was carried out according to the developed and patented technique (Method of treatment of cervicogenic headache: pat. 112871 Ukraine, 2016) [6]. Frequency of the tapes application procedure was 5 days. After a 2 day break, the taping procedure was repeated. The course of treatment consisted of 4 such procedures during a month. Kinesiotherapy in the form of therapeutic exercises (ThE) was prescribed to strengthen weakened muscles with increasing their endurance and creating a “common muscular corset” of the spine and to form the correct posture: the development of the position sense; the dynamic stereotype restoration. The ThE complex (T. Ye. Vilenskaya, 2006) mainly consisted of isometric exercises, supplemented by dynamic ones, which the children performed every other day for 30 minutes under the instructor’s direction. The main part of the complex ended with the performance of postisometric exercises [4].

The children involved in the study were assessed the HA intensity, which to some extent determines the condition of the patient and is a criterion for the PhT effectiveness. Self-

assessment of pain intensity in the children older than three years was conducted by the common scale with pictures of happy and unhappy faces — the Wong-Baker Faces Pain Rating Scale. It includes pictures depicting the gradation of emotions: from a smiling face, which means no pain (0 points of 5) to a distorted face with a grimace and crying, which means the most intense pain (5 points of 5). The scale has a corresponding digital coding.

Transcranial ultrasound dopplerography (TCDG) (Sonomed 325, 2, 4 and 8 MHz sensors) was used to assess the state of hemodynamics of the main vessels of the head and neck. The blood flow velocity of intra- (IC) and extracranial (EC) segments of vertebral arteries (VA), the asymmetry of blood flow of these arteries were evaluated, and attention was also paid at which side the velocity was faster. The index of resistance of these vessels (IR) was evaluated. During the rotating sample (RS), the vascular response was assessed (decrease or increase of blood flow) (%), and the outflow through the vessels was assessed by considering the parameters of the tentorial sinus, ocular veins, and vertebral veins.

*Methods of analysis:* descriptive statistics and testing of statistical hypotheses methods were used to characterize and analyze the results of the study [9]. The type of distribution of continuous random variables was determined by the Shapiro-Wilk's test. The arithmetic mean (M), its standard deviation (SD) and the confidence interval (CI), the median (Me) and its interquartile range — values of 25th (Lower Quartile — LQ) and 75th percent (Upper Quartile — UQ) were determined, which includes 50% values of signs in the series. Differences between ordinal qualitative indicators were identified by calculating the criterion of conformity of Pearson's xi-square ( $\chi^2$ ) with Yates' correction. Comparison of binary relative frequencies within one group or in two groups was performed by calculating Student's t-test. The study data was processed using the software product STATISTICA for WINDOWS 6.0.

The study is clinical, open, prospective, controlled. According to the organization of the methodology, the study complied with the provisions of the Consensus on Biomedical Ethics and was conducted in compliance with the principles of evidence-based medicine (Act No 7/15 of 06.07.2018).

### **The results of the study and their discussion:**

According to the results of the clinical examination, healthy and sick children differed significantly. In the main group, in addition to HA, 71.87% of children had other complaints. More often they complained of meteosensitivity (35.42% (34/96)), rapid fatigue (63.54% (61/96)) or had several complaints (35.42% (34/96)). The average score of HA intensity according to visual analogue scale (VAS) in the main group was  $2.15 \pm 0.79$  (95% CI: 1.98–

2.31), median — 2.0 (2.0; 3.0) points. 75.0% of sick children had the intensity of pain by VAS 2.0 and 3.0 points. Among the objective data, the most common signs of the undifferentiated DCT (UDCT): scoliotic posture or scoliosis in combination with tension of the cervico-occipital muscles, increased lumbar lordosis with joint recurvation —  $\chi^2=75.92$ ;  $p=0.0000$  compared with the control, the presence of more than three signs of UDCT (41.67% (40/96)), and X-ray examination — ICS in three or more segments in 69/96 (71.88%) and ICS in two segments — in 23/96 (23.96%) cases.

Primary examination (according to transcranial Doppler) in children of the main group revealed significant hemodynamic disorders in the vascular basin of the head and neck. An increase in blood flow velocity in two VA, especially in their intracranial segments 1.4–1.6 folds compared with the control, a significant asymmetry of blood flow — intracranial — 13.66 (6.98; 18.32)%, extracranial — 17.44 (9.30; 25.32)%) and a significant predominance of right-sided blood flow (intracranially in 69.8% of cases) are usually compensatory and indicate the development of collateral circulation, which is a consequence of possible compression or curvature of blood vessels in case of the cervical spine instability. Decreased IR values for intracranial segments of the two VA in the main group indicated a violation of the elastic properties of blood vessels. The results of RS are unfavorable, because after the test the blood flow rate in both VA significantly decreased (by 21.70–29.64%) in almost all children (95.8–97.9%). This indicated a decrease in reserves and impaired blood flow in VA associated with the negative extravasal effects of the surrounding structures. Disturbances of venous blood flow were also found (blood flow velocity in the tentorial sinus was increased 1.5 folds, in ocular veins — 2.1–2.4 folds), which is evidence of difficulty and deterioration of venous outflow. According to other researchers, all patients with dysplastic ICS have, to a different extent, hemodynamic disorders in the cervical spine and brain [7, 8].

Treatment with the combined use of KTP and ThE was prescribed to 60 children with HA syndrome on the background of ICS. The use of KTP and ThE resulted in significant improvement in the clinical condition of children immediately after treatment, which manifested itself in a decrease in the number of children with HA to 13.3% (8/60) of children. However, in 1 month after the end of treatment — 20.0% (12/60), and in 6 months — 30.77% (16/52) of children complained of headache. In the vast majority of these children, 90.0% (18/20) of the median of intensity of pain by VAS was 1.0 points, while before treatment 73.3% (44/60) assessed the gradation of pain by VAS from 2 to 4 points (Table 1).

Table 1

**Dynamics of the presence and intensity of headache in the examined children with the combined use of KTP and ThE, (abs. (%))**

Indicators	Healthy children (control) n=30		The main group, n=60							
			before treatment, n=60		after treatment, n=60		in 1 month, n=60		in 6 months, n=52	
	abs.	%	abs.	%	abs.	%	abs.	%	abs.	%
Headache										
No	60	100.0	0	0	52	86.67	48	80.00	36	69.23
Present	0	0	60	100.0	8	13.33	12	20.00	16	30.77
Significance of differences					p <sub>0</sub> =0.03843 p <sub>1</sub> = n/d		p <sub>0</sub> =0.00238 p <sub>1</sub> = n/d		p <sub>0</sub> =0.00000 p <sub>1</sub> = n/d	
Headache by VAS										
0	60	100.0	0	0	52	86.67	48	80.00	32	61.54
1	0	0	16	26.67	8	13.33	10	16.67	18	34.61
2	0	0	28	46.67	0	0	2	3.33	2	3.85
3	0	0	14	23.33	0	0	0	0	0	0
4	0	0	1	3.33	0	0	0	0	0	0
Significance of differences					p <sub>0</sub> =0.03843 p <sub>1</sub> =0.07271		p <sub>0</sub> =0.00989 p <sub>1</sub> =0.76015		p <sub>0</sub> =0.00000 p <sub>1</sub> = n/d	

**Notes:** 1.  $p_0$  — the significance of differences in comparison with the control group,  $p_1$  — in comparison with the values before treatment, which is determined by  $\chi^2$  criterion;

2. The note “n/d” indicates that  $p$  is not determined by the statistical program due to the peculiarities of the distribution of comparative data.

X-ray examination with functional samples did not reveal a clinically significant effect on morphological changes in the cervical spine. However, according to the X-ray examination of the cervical spine in 6 months in children of the 3rd subgroup decreased the number of cases with instability in three or more segments from 73.3% (44/60) to 26.9% (14/52).

According to the Transcranial Dopplerography data, the impaired blood flow in the intracranial segments of both VA under the action of KTP and ThE decreased significantly: in the right artery from 67.80 (58.70; 79.40) cm/s to 45.50 (42.10; 49, 60) cm/s ( $p=0.0000$ ), on the left artery - from 61.30 (53.90; 68.40) cm/s to 45.90 (42.80; 48.20) cm/s ( $p=0.0000$ ). The achieved blood flow velocity in both VA continued to decrease in 1 month after treatment and did not differ from the velocity at the control group, but after six months the velocity in these arteries increased again - on the right VA - to 50.00 (48.60; 54.40) cm/s, on the left VA - up to 47.10 (43.70; 49.80) cm/s). The asymmetry of intracranial blood flow in VA also decreased from 12.69 (5.53; 17.37)% to 4.67 (2.46; 8.23)% ( $p=0.0001$ ) and ceased to differ from control

not only at that moment of investigation ( $p=0.83602$ ), but also in 1 month - 4.87 (2.47; 7.92)% ( $p=0.69522$ ). However, in 6 months the asymmetry of blood flow on VA increased again and became statistically significantly different from the control value - 9.16 (6.37; 11.68)% ( $p=0.00723$ ). Before treatment, these patients had a predominant blood flow on the right VA (63.3% of cases;  $p<0.05$  compared with control), and immediately after treatment and in 1 month, the number of such children decreased to 46.75 (14/30) in both cases did not differ from the control group. In 6 months, a right-sided blood flow in the VA intracranial segments prevailed again - 76.9% (20/30) of cases. Reduced before treatment, the values of IR of both VA after the use of KTP and ThE increased significantly immediately after treatment: the right artery from 0.56 (0.52; 0.58) to 0.63 (0.58; 0.65) relative units (RU), left artery — from 0.55 (0.51; 0.57) to 0.63 (0.60; 0.64) RU, began to correspond to control values and remained unchanged until the end of observation.

The initial blood flow velocity in the extracranial segments of VA both on the right and on the left was increased and differed significantly from the control values. Immediately after the KTP and ThE course, the rate of extracranial blood flow in both arteries decreased statistically significant: at the right artery from 31.95 (27.70; 38.80) to 27.45 (25.40; 30.60) cm/s ( $p=0.0004$ ), on the left artery — from 30.55 (27.80; 33.80) to 26.80 (25.90; 29.40) cm/s ( $p=0.0002$ ). During the next observation period after the treatment, the achieved rate of extracranial blood flow on the right VA was preserved (in 6 months — 27.75 (25.70; 30.60) cm/s), on the left VA — slightly increased (in 6 months — 30.55 (26.40; 33.70) cm/s), but in both cases corresponded to control values. The significant asymmetry of extracranial blood flow in VA (17.44 (8.33; 24.46)%) revealed before treatment after KTP and ThE decreased almost 2.7 folds (to 6.48 (4.08; 12.36)%) and did not differ from the value at the control group (7.90 (4.95; 14.89)%). Subsequently, the asymmetry of extracranial blood flow increased again (after 6 months to 7.18 (3.11; 20.16)%), but still did not differ from the control value. The reduced before the treatment values of IR of two VA in their extracranial segments (on the right — 0.61 (0.57; 0.65) RU, on the left — 0.60 (0.54; 0.62) RU) after the use of KTP and ThE increased statistically significantly immediately after treatment (on the right — to 0.65 (0.62; 0.67) RU, on the left — to 0.65 (0.63; 0.68) RU), began to correspond to control values and remained the same during all the follow up period.

After the KTP and ThE course, the blood flow velocity on both VA after the rotational test improved, i.e. increased: on the right VA — from 22.60 (19.70; 27.50) to 26.30 (22.40; 28.10) cm/s ( $p=0.0324$ ), on the left VA — from 21.40 (18.20; 26.00) to 26.25 (23.40; 27.20) cm/s ( $p=0.0022$ ). However, it was unstable and in 6 months decreased to 22.95 (20.30; 27.30)

cm/s on the right VA and to 22.75 (21.40; 24.70) cm/s on the left VA (Table 2).

Table 2

**Dynamics of transcranial dopplerography indicators of the head and neck vessels after RS in the examined children with the combined use of KTP and ThE, (Me (LQ; UQ)), (abs. (%))**

Indicators	Healthy children (control), n=30	The main group, n=60			
		before treatment, n=60	after treatment, n=60	in 1 month, n=30	in 6 months, n=52
RS on the right VA, cm/s	38.30 (31.80; 43.80)	22.60 (19.70; 27.50)	26.30 (22.40; 28.10)	25.70 (20.70; 26.50)	22.95 (20.30; 27.30)
Significance of differences			$p_0=0.00000$ $p_1=0.03243$	$p_0=0.00000$ $p_1=0.04768$	$p_0=0.00000$ $p_1=0.45934$
RS on the right VA. Changes, %	27.97 (6.29; 35.65)	-28.71 (-36.22; -18.64)	-10.09 (-16.42; 2.14)	-11.10 (-18.55; -1.38)	-21.56 (-30.22; -17.19)
Significance of differences			$p_0=0.00000$ $p_1=0.00000$	$p_0=0.00000$ $p_1=0.00000$	$p_0=0.00000$ $p_1=0.02803$
RS on the right VA; direction of changes, abs. (%)					
Decrease of blood flow	16 (26.67)	60 (100.0)	44 (73.33)	46 (76.67)	52 (100.0)
Increase of blood flow	44 (73.33)	0 (0)	16 (26.67)	14 (23.33)	0 (0)
Significance of differences			$p_0=0.00030$ $p_1= n/d$	$p_0=0.00010$ $p_1= n/d$	$p_0=0.00000$ $p_1= n/d$
RS on the left VA, cm/s	32.75 (27.90; 38.60)	21.40 (18.20; 26.00)	26.25 (23.40; 27.20)	25.05 (23.10; 25.80)	22.75 (21.40; 24.70)
Significance of differences			$p_0=0.00001$ $p_1=0.00226$	$p_0=0.00000$ $p_1=0.01455$	$p_0=0.00000$ $p_1=0.29188$
RS on the left VA. Changes, %	16.87 (-1.49; 27.51)	-30.28 (-35.20; -18.93)	-7.91 (-11.11; 2.88)	-13.28 (-17.65; -8.14)	-19.13 (-25.70; -13.73)
Significance of differences			$p_0=0.00008$ $p_1=0.00002$	$p_0=0.00000$ $p_1=0.00001$	$p_0=0.00000$ $p_1=0.0107$
RS left VA direction of changes, abs. (%)					
Decrease of blood flow	16 (26.67)	58 (96.67)	40 (66.67)	56 (93.33)	52 (100.0)
Increase of blood flow	44 (73.33)	2 (3.33)	20 (33.33)	4 (6.67)	0 (0)
Significance of differences			$p_0=0.00190$ $p_1=0.15032$	$p_0=0.00000$ $p_1=0.78575$	$p_0=0.00000$ $p_1= n/d$

**Notes:** 1.  $p_0$  — significance of differences in comparison with the control group,  $p_1$  — in comparison with the values before treatment, which is determined by  $\chi^2$  criterion;

2. The note “n/d” indicates that  $p$  is not determined by the statistical program due to the comparative data distribution peculiarities.



The table 2 demonstrates that immediately after treatment the severity of changes in blood flow on two VA decreased after the combined use of KTP and ThE: on the right VA from -28.71 (-36.22; -18.64)% to -10.09 (-16.42; 2.14)% ( $p=0.0000$ ), on the left VA — from -30.28 (-35.20; -18.93)% to -7.91 (-11.11; 2.88)% ( $p=0.0000$ ), but in 6 months the blood flow disorders increased again: on the right — to -21.56 (-30.22; -17.19)%, on the left — to -19.13 (-25.70; -13.73)%.

The rate of venous outflow of blood in the tentorial sinus, at the right and left ocular arteries in children of the main group immediately after the use of KTP and ThE decreased statistically significant compared with baseline values: by the tentorial sinus from 75.05 (63.60; 83.40) to 56.35 (44.30; 63.90) cm/s ( $p=0.0000$ ), on the right ocular artery — from -7.49 (-8.42; -6.91) to -6.05 (-6.53; -5.39) cm/s ( $p=0.0000$ ), on the left ocular artery — from -7.31 (-8.19; -6.28) to -5.91 (-6.28; -5.30) cm/s ( $p=0.0000$ ) (Table 3).

Table 3

**Dynamics of indicators of venous outflow of the head and neck vessels according to transcranial dopplerography in the examined children with combined use of KTP and ThE, (Me (LQ; UQ))**

Indicators	Healthy children (control), n=30	The main group, n=60			
		before treatment, n=60	after treatment, n=60	in 1 month, n=60	in 6 months, n=52
Tentorial sinus, cm/s	50.20 (41.20; 60.70)	75.05 (63.60; 83.40)	56.35 (44.30; 63.90)	57.15 (49.50; 64.60)	62.10 (52.70; 69.20)
Significance of differences			$p_0=0.24880$ $p_1=0.00000$	$p_0=0.04057$ $p_1=0.00000$	$p_0=0.00231$ $p_1=0.00012$
Right ocular vein, cm/s	-3.28 (-6.51; 2.13)	-7.49 (-8.42; -6.91)	-6.05 (-6.53; -5.39)	-6.00 (-6.28; -5.09)	-6.58 (-7.15; -6.12)
Significance of differences			$p_0=0.00221$ $p_1=0.00000$	$p_0=0.00520$ $p_1=0.00000$	$p_0=0.00020$ $p_1=0.00005$
Left ocular vein, cm/s	-3.49 (-6.08; 1.91)	-7.31 (-8.19; -6.28)	-5.91 (-6.28; -5.30)	-5.89 (-6.19; -5.41)	-6.58 (-6.91; -6.06)
Significance of differences			$p_0=0.00275$ $p_1=0.00000$	$p_0=0.00813$ $p_1=0.00000$	$p_0=0.00009$ $p_1=0.00018$

**Note:**  $p_0$  — significance of differences in comparison with the control group,  $p_1$  — in comparison with the values before treatment, which is determined by  $\chi^2$  criterion.

The outflow of blood through the tentorial sinus immediately after PhT did not differ from the control, however, in other cases did not correspond to the control values. The

achieved outflow of venous blood lasted another 1 month, and in 6 months after treatment increased slightly, which indicated its deterioration (Table 3).

Discussing the obtained data we underline that results of FhT indicate the achievement of the unidirectional favorable dynamics of almost all the survey parameters. The study showed that the comprehensive use of the KTP and ThE course in patients with HA syndrome on the background of ICS led to a significant improvement in their clinical condition immediately after the treatment (86.7% of children did not complain of HA) and in 6 months the headache did not recur in most children (69.2%). In the majority of children (90.0%) the median intensity of pain by VAS was 1.0 points, while before treatment it was from 2 to 4 points in 73.3% of patients. Comparing the obtained data with the publications of other authors, we prove that the methods used can significantly improve the quality of life of children with vertebrogenic cephalgia by reducing frequency and intensity of headache [1, 3, 10-13]. We can also state that the combined use of KTP and ThE normalized blood flow in the EC segment of both HA for the entire period of observation, improved for a long time elastic-elastic properties of both VA in both IC and EC segments ( $p = 0.0000$ ), improved blood flow in the IC segment of both HA, with a decrease in its asymmetry ( $p = 0.0001$  - compared with the original data and control -  $p = 0.83602$ ), for a period of up to 6 months), improved the response of both VA to the negative extravasal effects of surrounding structures, and venous outflow from the vessels of the head and neck (both according to the direct sinus and ocular veins) ( $p = 0.0000$ ), which continued improving in 1 month, but somewhat worsened in 6 months again. So, the analysis of own data and comparison with other studies allows suggesting that the use of KTP in combination with ThE can optimize impaired vascular hemodynamics of VBB (blood flow, elastic properties of blood vessels, response to negative extravasal effects of surrounding structures, venous outflow) in children with the HA syndrome on the background of ICS [6-8]. Our results indicate the inability of the studied methods to significantly affect the morphological changes in the cervical spine, they only improved for a long time by reducing the instability of three or more segments (from 73.3% ( $\chi^2 = 90.63$ ;  $p = 0.0000$  compared to control) up to 26.9% of cases), which correlates with data from other researchers [2, 5, 13, 14]. However, in conclusion, we emphasize that we have not found complete analogues of our research in the available literature, which indicates its scientific novelty.

### **Conclusion:**

Methods of physical therapy with the use of Kinesio Taping and therapeutic exercises can reduce the manifestation of pain, optimize blood flow of the vertebrobasilar basin,

thereby improving the quality of life of children with headache syndrome on the background of instability of the cervical spine. Structural and morphological changes in the cervical spine (according to X-ray data) did not change significantly after the applied methods (except for a decrease in the number of children with instability in 3 or more segments). The studied methods do not allow for a long time (6 months) to keep all the achieved clinical and functional results at the same level, although mostly they remain better than before treatment ( $p < 0.05$ ). Partial regression of positive results confirms the need for longer courses or their repetition no later than in 6 months. Optimization of the condition of the examined children confirms the prospects of practical application and further research of these methods effectiveness in pediatrics.

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