

# Optimization of Plasma Bioregulatory Effects in Children 5-6 Years Old with Scoliosis against the Background of Daily Wearing of Medical and Preventive Clothing

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## Abstract

For children 5-6 years old, scoliosis is characterized by a violation of bioregulatory effects in the blood, which is combined with inhibition of their physical development. In order to eliminate the phenomena of scoliosis and normalize the level of bioregulatory compounds in plasma, the observed children were recommended to wear medical-preventive clothing every day. As a result, six months of its use in observed children with scoliosis was marked by a positive dynamics of the indicators taken into account. Observed children with scoliosis during daily wear during 6 months of the author's version of medical and preventive clothing attained weakening of the curvature of the spine, increasing strength and endurance of the muscles of the trunk, gradual restoration of the balance of bioregulatory substances in the plasma. As a result of the study, it can be argued that the daily wearing during six months of medical and preventive clothing removes scoliotic symptoms in children with scoliosis and leads to a level of normal plasma content of bioregulatory substances.

**Keywords:** Children; Preschool age; Scoliosis; Plasma; Biologically active substances; Aggregation; Medical and preventive clothing

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## Introduction

The growth and development of the child's body is often accompanied by the onset of negative morphofunctional changes, including in the musculoskeletal system. More often other disorders in children are recorded scoliosis [1,2]. It is known that the development of the scoliotic process weakens the overall viability [3]. This is caused by the formation on its background of dysfunctions in various internal organs [4,5]. It is proved that the appearance of scoliosis worsens the functioning of the cardiovascular system and a number of blood parameters [6,7]. Also, in children with scoliosis, there are disorders in the process of microcirculation, which contributes to the growth of hypoxia in all cells of the body [8]. The resulting small chronic oxygen deficiency in the tissues of these children leads to a permanent weakening of their anabolic processes and disrupts their overall resistance [9].

The wide prevalence of scoliosis in children and the risk of a number of persistent dysfunctions occurring against it retain the need to continue searching for effective variants of health effects when curving the spine with the obligatory allowance for the dynamics of the plasma level of bio regulators [10]. Earlier in the clinic [11,12] and in the experiment [13,14] the possibilities of various effects on the

organism in terms of influence on microcirculation were evaluated and their effectiveness was clarified. Also in children with scoliosis, the possibility of weakening the aggregation of blood cells by means of non-medicamentous effects was proved [15]. Given the low adherence of children to daily long-term physical therapy [16], it is clear that the need to continue searching for therapeutic options is becoming clear. Of great importance in the conducted search is the degree of adherence of children to the type of health-improving effect being tested and the ability to optimize the regulation of microcirculation processes with its help. This option of health effects on the children's body in the future can become the basis of mass prophylaxis of scoliosis progression and a guaranteed way of maintaining the health of the child's internal organs with the scoliosis that has already arisen. An alternative to curative physical culture to minimize the manifestations of scoliosis can be the daily long-term use by children of curative and preventive clothing (MPC). Particular confidence in the success of this line of research is inspired by a high commitment to children's MPC, which exceeds that of physical therapy [17]. At the same time, the effect of prolonged wearing of MPC on the plasma level of biologically active substances, significant for microcirculation, remains practically unexplored. For this reason, our goal is to clarify the dynamics of the plasma level of biologically active substances, significant for microcirculation, in



children 5-6 years old with scoliosis of I-II degree as a result of their daily wearing of MPC for half a year.

## Materials and Methods of Research

The research was conducted on children living in Central Russia (Moscow city and Moscow region). We took 34 healthy children of both sexes at the age 5-6 years (height  $123.6 \pm 1.41$  cm, body mass  $24.2 \pm 1.38$  kg), and also 39 children of both sexes of the same age with scoliosis of I-II degree (height  $118.7 \pm 0.73$  cm, body mass  $21.2 \pm 2.10$  kg) at full absence of any accompanying diseases in them. Given research was approved by local Ethics Committee of Russian State Social University on May, 14<sup>th</sup>, 2015 (Record No 5). Both parents of each taken into the research child gave written informed agreement on participation of their children in the research. The children themselves agreed in oral form in the presence of their parents and witnesses.

Deviation degree of spinal column in children was determined with the help of a test with pasting of special cord with lead in the field of the 7<sup>th</sup> cervical vertebra by adhesive plaster [3]. The distance from the vertical position till acanthus was found with the help of this lead. It characterized the degree of spinal curvature in frontal plane. The value of humeral index was calculated by dividing the value of a child's humeral width from the chest side (cm) on the value of humeral width from the back side (cm) [17].

The degree of spinal mobility in examined children was estimated in the course of body tilts forward, backwards and sideward. In the course of body tilts forward at straightened legs we determined the distance from the middle finger of each hand till floor surface (cm). In the case of body tilts backwards we determined the difference of line length (cm) which connected the tops of acantha of the 7<sup>th</sup> cervical vertebra and initial part of intergluteal fold. The estimation was conducted in vertical position and at the tilt backwards. Lateral spinal mobility was found in the course of distance estimation from the ends of hands' middle fingers till floor at maximum tilt sideward from standing position. The more was the given difference, the more spinal mobility in frontal plane was [3].

In our research we determined the activity of the processes of lipids' peroxidation (LPO) in blood plasma which was registered according to the content of thiobarbituric acid (TBA)-active products in it with the help of a set produced by the firm "Agat-Med" (Russia) and to the level of acylhydroperoxides (AHP) [18]. We also registered antioxidant activity (AOA) of blood [19].

Using the enzyme immunoassay, concentrations of P-selectin and PECAM-1 molecules were determined in plasma (Bender MedSystems GmbH, Austria).

In blood plasma of examined children we determined the content of thromboxane A<sub>2</sub> metabolite-thromboxane B<sub>2</sub> and prostacyclin metabolite -6-keto-prostaglandin F<sub>1α</sub> by enzyme immunoassay with the help of sets produced by the firm "Enzo Life science" (USA). We also determined the summary content of nitric oxide metabolites [20] in children's plasma.

All the children from experimental group were recommended to wear daily medioprophyllactic clothes, designed by the author, for scoliosis correction [21]. Applied MPC contained a button band and a panel, was provided by elastic straps in the upper part. Their ends were connected with both panel sides. The panel was made of nonstretching material, and there were pockets with inflexible plates on it in the area of blade bones' inner corner. The ends of elastic straps were fixed to both panel sides on the level of blade bones, and pockets were attached

to the reverse side of the panel. The panel and the button band were supplied with sleeves, a collar, a skirt or trousers of any material. Given MPC were put on in vertical position. The arms were drawn backwards with the help of elastic straps. Inflexible plates pressed the inner part of blade bones promoting flattening of the back. The presence of elastic belt didn't hamper normal breathing and, at the same time, promoted right fit of clothes on the body. The clothes were worn during the whole day. They were put off before going to bed. In given research all the children with scoliosis were recommended daily wearing of MPC during the whole day for 6 months.

The children from experimental group were observed and examined at the beginning and in 3 and 6 months of continuous MPC wearing. The control group was observed and examined once. Received in our research results were processed by Student's (t) criterion.

## Results of Research

Already in 3 months of continuous MPC wearing the children with scoliosis had lowering of deviation degree from the vertical position on 55.2%. It additionally decreased to the end of the research till  $1.46 \pm 0.14$  cm. In 3 months of MPC application the children with scoliosis had value lowering of humeral index on 5.5%. To the end of the research it reached the value  $0.82 \pm 0.06$  (Table 1).

Application of MPC for 3 months provided the children with scoliosis with a tendency to the increase of spinal mobility in three planes which reached the level of static signification in 6 months of the research (to the right side till  $27.9 \pm 0.17$  cm, to the left side till  $27.8 \pm 0.27$  cm, backwards till  $18.7 \pm 0.38$  cm).

Daily wearing of MPC was accompanied by weakening of LPO processes in plasma of children with scoliosis. So, already in 3 months of observation the quantity of AHP and TBA products in plasma lowered from  $2.21 \pm 0.18$  D<sub>233</sub>/1 ml and  $4.38 \pm 0.24$  umol/l (control values- $1.65 \pm 0.14$  D<sub>233</sub>/1 ml and  $2.99 \pm 0.22$  umol/l, respectively) till  $1.98 \pm 0.18$  D<sub>233</sub>/1 ml and  $3.88 \pm 0.22$  umol/l, respectively. By the 6<sup>th</sup> month of MPC application the content of AHP in plasma of children with scoliosis reached  $1.82 \pm 0.17$  D<sub>233</sub>/1 ml at the decrease of TBA-active compounds in it till  $3.38 \pm 0.19$  umol/l against the background of plasma AOA strengthening from  $23.6 \pm 0.34\%$  at the beginning till  $26.1 \pm 0.24\%$  by the end of observation (control values- $27.2 \pm 0.16\%$ ).

Against the background of wearing children with scoliosis, LPO revealed a gradual decrease in the initially increased plasma concentrations of the registered adhesion molecules (Table 1). For half a year of wearing LPO in children with scoliosis, the levels of P-selectin and PECAM-1 significantly decreased by 12.3% and 16.3%, respectively, and reached a level close to control.

Initial misbalance of arachidonic acid metabolites in blood of children with scoliosis was gradually suppressed against the background of daily MPC wearing by them. By the 6<sup>th</sup> month of observation the level of thromboxane B<sub>2</sub> in their plasma turned out to be higher in comparison with the control level just on 7.9% when the level of the derivative of its functional antagonist -6-keto-prostaglandin F<sub>1α</sub> was lower in comparison with the control one just on 3.3% (Table 1). By the end of observation it was accompanied in examined children with scoliosis by lowering of the quantitative content of nitric oxide summary metabolites in their blood plasma on 18.5% till the level near to the control one.

## Discussion

Each organism has a unique genetic code, in which its structural and



**Table 1.** The dynamics of morpho-functional and hematological characteristics of examined children with scoliosis against the background of medioprophyllactic clothes' wearing.

Registered parameters	A group of children with scoliosis against the background of medioprophyllactic clothes' wearing, n=39, M ± m			Control, n=34, M ± m
	Initial State	3 Months	6 Months	
Deviation of spinal column from the vertical position, cm	4.5 ± 0.29	2.9 ± 0.37 p <sub>1</sub> <0.01	1.46 ± 0.14 p <sub>1</sub> <0.01	0.2 ± 0.004 p<0.01
Value of humeral index	0.72 ± 0.16	0.76 ± 0.09	0.82 ± 0.06 p <sub>1</sub> < 0.05	0.90 ± 0.06 p<0.01
Degree of spinal column mobility in the course of tilts to the left side, cm	21.6 ± 1.24	24.5 ± 0.30	27.8 ± 0.27 p <sub>1</sub> <0.05	32.8 ± 1.45 p<0.01
Degree of spinal column mobility in the course of tilts to the right side, cm	22.4 ± 1.34	24.7 ± 0.24	27.9 ± 0.17 p <sub>1</sub> <0.05	32.5 ± 2.44 p<0.01
Degree of spinal column mobility in the course of tilts backwards, cm	14.5 ± 0.72	16.3 ± 0.41	18.7 ± 0.38 p <sub>1</sub> <0.05	22.6 ± 0.72 p<0.01
Thromboxan A <sub>2</sub> , pg/ml	210.2 ± 0.72	189.1 ± 0.64	168.5 ± 0.58 p <sub>1</sub> <0.05	156.2 ± 0.64 p<0.01
6-keto-prostaglandin F <sub>1α</sub> , pg/ml	72.6 ± 0.34	75.7 ± 0.58	78.1 ± 0.44 p <sub>1</sub> <0.05	80.7 ± 0.45 p<0.05
nitric oxide's metabolites, umol/l	25.9 ± 0.35	27.2 ± 0.41	30.7 ± 0.46 p <sub>1</sub> <0.05	32.4 ± 0.38 p<0.05
P-selectin, ng/ml	107.8±0.42	101.4 ± 0.46	96.0 ± 0.38 p <sub>1</sub> < 0.01	92.1 ± 0.34 p<0.01
PECAM-1, ng/ml	52.7 ± 0.34	48.6 ± 0.30	45.3 ± 0.29 p <sub>1</sub> < 0.01	44.2 ± 0.23 p<0.01

functional parameters are recorded, as well as predisposition to various pathologies [22,23]. The realization of this predisposition is strongly caused by environmental influences on the organism [24,25] and is able to intensify with time [26]. This also applies to scoliosis, which appears in childhood during active growth in case of predisposition to it under the influence of unfavorable environmental factors [27].

It is noted that the development of scoliosis in children significantly worsens the metabolism and hemocirculation processes, thereby worsening the work of internal organs [28,29]. Of great importance in the development of these dysfunctions in scoliosis is the violation of micro-rheological processes in the blood [30]. Of particular importance in this is the weakening of the antioxidant protection of the plasma with the increase in the amount of LPO products in it [31]. These substances cause changes in the membranes of blood cells and worsen all their functions [32,33].

Very sensitive indicators of aggregation activity of blood cells are the content of cellular adhesion molecules in blood, including P-selectin and PECAM-1. Their levels indicate the degree of expression of receptors on the surface of blood cells and the endothelium. In this regard, they are considered important markers for the viability of blood cells and the endothelium. Therefore, an increase in the plasma level of these molecules suggests that it is one of the mechanisms of growth of the activity of blood cells in vivo [34].

Currently, the world science is increasingly beginning to seek new approaches to the recovery of various groups of patients [35-36]. One of the new and effective options for combating pathology is the use of LPO [37,38], the development of variants of which is carried out taking into account the latest achievements of science [39-41]. Given the fairly large prevalence of scoliosis, the development of LPO for children with this pathology was of high importance [42-44]. However, for the final evaluation of all aspects of the positive effects of this garment on the child's body, additional, well-planned studies are needed, which was started in the work carried out by the authors.

It was found out that the regular wearing of the MPC provides a decrease in the intensity of LPO in the plasma, minimizing the violation of posture, there by stimulating the functioning of all internal organs. The weakening of the processes of lipid peroxidation in children's bodies ensures the optimization of bio regulatory effects in the blood plasma and apparently the activity of receptors on the surface of blood cells. The decrease in the plasma level of P-selectin and PECAM-1 in children with scoliosis, which had daily MPC, apparently contributes to optimizing the activity of these processes and provides an improvement in the conditions for capillary blood flow and metabolism in the tissues of these children [45].

In such conditions the synthesis of biologically active substances which can limit blood cells aggregation, lowers in vascular wall of children with scoliosis. At that, the level of proaggregants rises in their blood. So, found intensity of thromboxane formation and output weakening of its functional antagonist-prostacyclin-create misbalance of arachidonic acid metabolites in children with scoliosis. Given disturbances are aggravated in 5-6-year old children with scoliosis by developing weakening of NO production in vascular wall. It may happen in the result of endothelial NO-synthase weakening by surplus LPO in plasma [46].

It was established in our research that daily MPC wearing led to optimization of bioregulatory properties of plasma in children with scoliosis. It could be explained by the fact that application of MPC was accompanied in them by weakening of LPO processes in blood plasma and erythrocytes. At that, synthesis strengthening of biologically active substances which could limit blood cells aggregation – prostacyclin and nitric oxide, took place in vascular walls of daily MPC wearing children with scoliosis [47]. It was accompanied by lowering of proaggregants' quantity in their blood. In this connection we could consider that weakening of thromboxane formation and output strengthening of its functional antagonist-prostacyclin-in the result of daily MPC wearing by children with scoliosis led to balance restoration of arachidonic acid metabolites in their blood. It was very important that it was added by developing activation of endothelial NO-synthase. It might happen in



the result of LPO inhibition in plasma. Given changes, developed in children with scoliosis against the background of 6 months' daily MPC wearing created necessary conditions in their blood for approaching the control level by the indices of their quantity of bioregulatory compounds in their plasma. This greatly contributed to the fact that children with scoliosis smoothly decreased the risk of micro thrombogenesis in their organs.

It becomes clear that against the background of wearing MPC in children 5-6 years old with scoliosis after 6 months, it is possible to attenuate the activity of LPO in plasma by optimizing the level of biologically active substances important for micro circulation, which exceeds the level that it is possible to reach in this category of children within six months with the help of daily sessions of medical physical training and several massage courses [15]. This result indicates a high effectiveness of the tried and tested approach to over coming the phenomena of scoliosis. The achieved optimization of the level of biologically active substances that determine the rheological processes in capillaries is the basis for increasing the inflow to the tissues of the required amount of oxygen and nutrients.

Conventional signs: p-signification of parameters' differences of children with scoliosis and control group.  $p_1$ -dynamics signification of accountable indices of children with scoliosis in the course of correction in comparison with the beginning.

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